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Introduction – Intra-Cross-Craft Analysis Workshop: Investigating Linkages within Craft Industries

Cross-Craft and Intra-Cross-Craft Interaction

Cross-craft interaction is, by now, a very familiar term to archaeologists studying all manner of past production. The concept was first introduced into the archaeological literature in 1989, with the publication of the proceedings of the fourth symposium on ceramics in history and archaeology, which took place in 1987.[1] Although initially confined to ceramics, there has been an explosion in the variety of industries to which this analytical framework has been applied.

Cross-craft interaction is a tool through which the known and potential relationships between different industries can be explored, thus opening up new avenues of research. These interactions appear in many forms; what has been truly groundbreaking about the cross-craft interaction analytical framework is that scholars have been able to use it to consider other factors well beyond important but easily observed phenomena such as the sharing of motifs or tools. Such analysis is often founded upon understanding the practicalities within which past craftspeople were embedded: their daily routines, their gestures, their relationships with their clients, their opportunities for interaction with other craft specialists and thus for discursive or non-discursive knowledge transfer.[2] Cross-craft interaction is, therefore, one of the few mechanisms recognised by archaeologists as enabling internally inspired change within societies[3] in a field that is still dominated by external forces as the explanation for innovation.

I first proposed the need for an explicit framework to tackle linkages within craft industries, namely intra-cross-craft interaction,[4] at *Sympozjum Egejskie: 5th Conference in Aegean Archaeology* held in Warsaw in June 2017. This presentation was published in 2022.[5] Of course, the potential to use the cross-craft interaction framework to study linkages within closely related material industries was acknowledged right from the very first introduction of the term.[6] Nevertheless, the use of the expression "possibly a different ceramic craft",[7] points to the perceived need for a conceptual distinction between crafts in order to apply the cross-craft framework, a difference that is acknowledged by scholars through established divisions between industries based on their target material or artefact output. Indeed, the predominant trend in cross-craft studies has been to search for interactions across two or more industries clearly distinguished by target material or artefact output, and this approach has been highly successful.

Yet, the complexity and diversity presented by my own field of study, namely metallurgy, prompted what was initially just a thought experiment: could applying the cross-craft interaction framework *within* an industry yield any further insights into the realities of past production? To attempt this, it was necessary to consider each one of these monolithically defined industries as a collection of interlinked crafts. This perspective immediately highlights the existence of certain assumptions within interpretations,[8] as well as the fact that archaeologists have often taken for granted the linkages within and between loci of production, such as workshops or resource extraction sites.[9]

[1] McGovern *et al.* 1989.
[2] Brysbaert 2007, 331.
[3] Rebay-Salisbury *et al.* 2014, 2.
[4] A term that I freely admit is rather unwieldy, and I welcome any suggestions for a more concise term, or at least one that requires fewer hyphens.
[5] Aulsebrook 2022.
[6] McGovern 1989, 1.
[7] McGovern 1989, 1.
[8] See, for example, Aulsebrook 2022, 111 n. 16.
[9] Where the latter have been investigated, the focus has often been on reconstructing trade networks and establishing the existence of mechanisms of control over important resources, rather than analysing the required coordination between the needs of craftspeople and the available supply of raw materials.

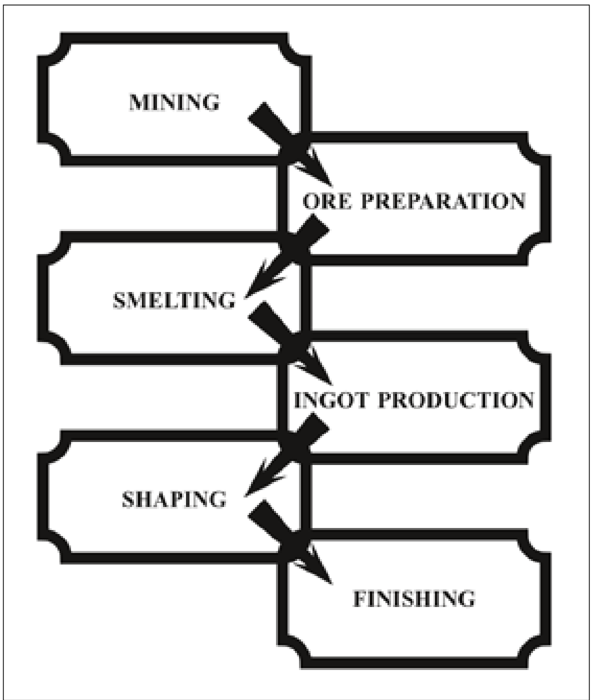

Fig. 1. The basic *chaîne opératoire* for metallurgy; each one of these stages is itself comprised of multiple steps and choices that can only be revealed through detailed artefactual analysis, an approach that has only recently become more widespread.

As with cross-craft interaction, the use of the *chaîne opératoire* model provides a way through which such linkages can be identified, but it is especially important for the intra-cross-craft approach for these to be made as detailed and individualised for each end product and community as possible (Fig. 1). This can only be achieved through in-depth analysis of artefacts, tools, resource extraction sites, *etc*., an approach that is facilitated by recent developments in various analytical techniques, including microscopy and the now numerous means of determining elemental composition, that have enabled such investigation to be carried out at a much broader scale than hitherto possible. Returning again to metallurgy specifically, the ability to, for example, extract gold or form a vessel through completely different processes that yield almost indistinguishable outcomes underlines the need for such a detailed approach if archaeometallurgists are to move beyond generic narratives towards models of craft practice that are capable of acknowledging the unique characteristics of each society under study.

The Intra-Cross-Craft Analysis Workshop

The *Intra-Cross-Craft Analysis Workshop: Investigating Linkages within Craft Industries* was held in hybrid mode on 15th March 2022, as part of the Third Conference of the Faculty of Archaeology at the University of Warsaw: 'Przeszłość ma przyszłość!/The Past Has a Future!'. The primary aim of the workshop was to discover whether the intra-cross-craft analytical framework, conceived within the specific sphere of archaeometallurgy, was also of use in the study of other past industries. The remit was intended to be as wide-ranging as possible, with participants representing the different knowledge domains of universities, research labs, museums and modern craft workshops. Sadly, it was not possible for all the participants to contribute to these proceedings which, nevertheless, still strongly convey the depth and breadth of the presentations and discussion.

Nikolas Papadimitriou and Akis Goumas jointly presented *Interaction among Master Artisans in Early Mycenaean Times*. They discussed the patterns of cross-craft and intra-cross-craft visible through an analysis of highly decorated Mycenaean weapons, including the famous Lion Hunt Dagger, demonstrating the range of different bodies of knowledge and advanced techniques, such as 'gold embroidery'[10] and inlay, required to manufacture these magnificent objects. Detailed examination of the Lion Hunt Dagger revealed a possible breakdown in communication between individual craftspeople working on this piece, as the attached hilt plates were made too long and caused damage to the intricate inlaid design on the blade. Reconstruction of the varied *chaînes opératoires* enabled their research team to pinpoint a change in relations between skilled artisans after the 16th century BC, when emphasis shifted from multiple craftspeople working together, probably in the same workshop setting, to make unique artefacts, to the repeated production of the same model but using different materials. They also showed how a decorative technique was repurposed for practical applications, a clear example of intra-cross-craft interaction. Finally, they emphasised how such decorative weapons were concentrated in a few tombs in specific locations around Greece, a reminder that these artefacts were likely commissioned by patrons and thus the important impact such individuals had on the production process for these high quality objects.

In his presentation, Peter Northover posed the question *How does a Workshop Work?* With so few archaeological traces of prehistoric metallurgical workshops,

[10] Konstantinidi-Syvridi *et al.* 2022.

answering this is not straightforward. However, by looking to a workshop that operated during a time period that used the same basic craft technology but is historically documented, he demonstrated that it is at least possible to survey the types of variables and factors that must be considered. Through the case study of William Forbes, who supplied copper to the British navy during the 18th century AD, the nature of the premises, number of craftspeople involved and auxiliary services, such as transport, could be discussed, and analysis conducted on aspects such as wastage. Such information is vital to understand the background against which cross-craft and intra-cross-craft interactions could take place. Returning to prehistory, he then proposed that finds like the Isleham Hoard, an exceptionally well-preserved group of artefacts from east England that originated from a workshop, could provide complementary evidence through part-finished objects, rejects and repaired manufacturing defects, shedding light, for example, on the level of quality that was tolerated. His final point drew upon another find from east England that demonstrated the specificity of knowledge possessed by Bronze Age metallurgists and their ability to access rare resources to achieve their aims. Nevertheless, knowledge concerning the wider supply chains required to operate prehistoric metallurgical workshops, based on the analogy with that of Forbes, remains difficult to obtain from the currently available evidence, leaving a significant lacuna with no clear pathway towards resolving this situation.

The contribution by Nadia Ben-Marzouk and Giulia Tucci, *Foreign Imitation in Local Faience Production? (Re)Assessing the Beth Shean Level IX Stamp Seal Group through Intra-Cross-Craft Analysis*, was based upon their ongoing research into faience seal production in the Late Bronze Age southern Levant. Previously it had been accepted that Middle Bronze Age production consisted of generic imitations of Egyptian scarab stamp seals, but that into the Late Bronze Age there was a shift to using direct impressions made from imported Egyptian scarabs as models for moulds. Not only did they conclusively demonstrate that this was physically impossible, they were also able to find strong continuity between the Middle and Late Bronze Ages that had been hitherto overlooked, by considering the role of the local jewellery industry in particular. These southern Levantine scarab stamp seals were made in a multitude of different materials beyond just faience, such as bone, wood and various stones, including, most importantly for their argument, steatite. This stone was also in common use for jewellery moulds, which would have been made using the same techniques, expertise and tools. The seals themselves were often strung as amulets or set into rings, strengthening this link between seal and jewellery production. Analysing the intra-cross-craft connections required to produce the faience scarab stamp seals revealed the need for close linkages between different material industries that would have been facilitated by the clustering of various specialised workshops within the setting of temples. Their research prompts a new perspective on long-term debates concerning local versus foreign production.

Anastasia Dakouri-Hild used the special role of the city of Thebes in the production of Mycenaean ornamental material culture to examine the importance of cross-craft fertilisation. *Jacks of all Trades: towards an Understanding of Cross-Craft Fertilization in the Mycenaean Ornamental Industries*, focused on the Kordatzi site, one of the 11 Palatial Period workshops and depots identified at Thebes. She first discussed what evidence should underpin the identification of a workshop, arguing that the more mixed the material, the less likely that a space functioned as a workshop because some level of internal coherence is required, even in multimedia settings. Indeed, she emphasised that this approach was integral to the successful production of complex objects designed to provoke a multi-sensory experience through combining materials from diverse sources. Augmented through her own personal examination of the material, she was able to identify a range of processes being carried out at the Kordatzi site that covered gold-, stone- and glassworking which showed a variety of techniques being applied within the same environment, whilst also noting certain materials, like ivory, and certain stages, like casting glass, were excluded. Burnt material deposited nearby, which predominantly featured ivory, was interpreted as the remains of an earlier workshop on the premises. This would seem to indicate that these multimedia workshops dynamically changed their specialisation based upon their commissions and available raw materials, rather than acting as static silos of separated bodies of knowledge.

Agata Ulanowska used her presentation, *How many Flax Seeds for a Shirt: Textile Production in Bronze Age Greece from an Intra-Cross-Craft Perspective*, to emphasise that the intra-cross-craft interaction approach had already been integral to textile archaeology well before 2017, at least in part due to the long-term focus on the *chaînes opératoires* for textile production. These are especially diverse and complex, requiring the integration of both *factors*, such as the material properties and processing needs of various fibres, and *decision-making agents* in order to gain a thorough understanding. She argued that higher-quality products may have required greater coordination between factors and different agents along the production sequence and that the intra-cross-craft approach is most effective when applied to end products, which is problematic for the study of Bronze Age Greece, with so few extant textiles. This, along with a lack of evidence more broadly, means that the decision-making agents in particular are difficult to reconstruct, leading to the creation of generalised cross-cultural narratives without a clear path towards a level of specificity which can take into account the individual circumstances of each textile-producing community. Nevertheless, through her own research on Bronze Age Greek textile imprints she has been able to demonstrate a wider diversity of craft practices than hitherto expected, which potentially will shed light on intra-cross-craft interaction during this period. She concluded by answering the question set in her title: approximately 1800–2100.

Katarzyna de Lellis-Dany and Magdalena Woźniak shared their results obtained thus far with their preliminary research into the production of what is often considered a humble, yet vital, object to past communities: the spindle whorl. In their presentation *Intra-Cross-Craft Approach to Ceramic Spindle Whorls from Old Dongola, Sudan*, they discussed both the cross-craft and intra-cross-crafts aspects that lay behind their production. Generating usable spindle whorls required coordination between spinners and ceramic specialists, whereas analysis of their production sequence highlighted the re-purposing of ceramic techniques. Identifying two different methods of manufacture, they concentrated on the re-use of ceramic sherds through shaping and drilling. They were able to demonstrate that the drilling technique employed for these perforated flat rounded discs was borrowed from that used to drill holes to repair pottery vessels with leather straps. The method of drilling also showed awareness of the differential hardness of the inner and outer surfaces of the ceramic. Through experimental archaeology they were able to recreate similar objects using ancient sherds, establishing that this production process could have been carried out in ordinary households because it did not require specialised tools or facilities, and the raw material was easily obtainable. Comparing the results from using the handmade Funj ware and wheelmade Makuria ware, they discovered that the latter was far harder and slower to work, but made a product whose durability probably outweighed the additional investment of time.

Laura Mazow demonstrated how the intra-cross-craft approach could generate a new perspective on a humorous didactic Akkadian text from Ur. In *Re-Examining at the Fullers UET 6/2, 414 as a Dialogue between Weaver and Fuller*, she proposed that the second unidentified figure with whom the fuller was in dialogue was a weaver, rather than, as previously suggested, a difficult customer. Thus this text was intended to capture that stressful moment when one expert craftsperson must commit an unfinished object, that nevertheless embodies their investment of time, skill and effort, into the care of another expert craftsperson. The weaver pompously provides very detailed instructions on how to proceed which, through their specialist knowledge, the fuller knows would result in disaster: an itchy ill-fitting garment. Mazow identified three particular vulnerabilities, the fringe, shrinkage and nap, and illustrated how a highly skilled fuller would have controlled these factors to obtain the best possible outcome based on extensive experience, including their knowledge of different finishing techniques. The final retorts of the fuller, therefore, should be understood not as discontent with the proposed remuneration, but as the justifiable complaint of a professional whose expertise has been called into question by someone whose ignorance and lack of self-awareness is galling.

Proceedings of the Workshop

The following five papers in this special issue of *Światowit* provide a snapshot of the possibilities that are opened up by taking an explicitly intra-cross-craft led approach. It opens with Kyle Jazwa's paper *Intra-Cross-Craft Interaction, Cross-Craft Interaction, and Architectural Innovation in Mainland Greece from the Bronze Age to the Archaic Period*, which focuses on ceramic roof tiles. Astonishingly, this innovation appeared on three separate independent occasions in Greece during this study period. He considers and compares the cross-craft and intra-cross-craft processes in train during each one of these distinctive occurrences, examining the links apparent throughout the development of ceramic roofing tiles to other ceramic and architectural industries.

Next comes a rather experimental paper, a collaboration between Dawn Hoffmann and me, which looks to demystify the intricacies of metallurgy through experiential and experimental archaeology. *The Metals' Family Tree and their Separate Branches: an Experiential Journey* is a double length paper in two parts. In the first, common household objects are used to guide readers through an introduction to the differing properties of metals, which have formed the backdrop to metal production throughout the ages. In the second part, the challenges and advantages of working with multiple metals simultaneously to create artefacts is discussed and illustrated through objects Dawn Hoffmann has produced, elucidating the thought processes that lie behind these complex choices.

We return to the realm of ceramics again with Nancy Serwint's paper *The Coroplast and the Potter: Considerations on Cross-Craft Specialists*. Terracotta sculpture production in the eastern Mediterranean underwent a series of innovations during the first millennium BC. Using material from the Cypriot site of Marion, she compares the technological practices of coroplasts with potters, noting similarities and suggesting specific instances for the sharing of knowledge and resources. Within the coroplastic industry itself, she is able to document the presence of distinct types of craftspeople, indicating greater complexity in its organisation than previously acknowledged. She concludes by presenting the approach being developed to take this research forward, through fingerprint analysis to trace the contribution of individuals.

The following paper, *Marble Extraction and its Industry: Case Study of the Vathi Quarry on Tinos Island* applies an intra-cross-craft approach to consider the interaction required for successful stone extraction at the primary level within the quarry, as well as the broader linkages between quarries and the end products of sculptors working across the Mediterranean. The interdisciplinary team, comprising Vasiliki Anevlavi, Frans Doperé, Alkiviadis Sideridis, Walter Prochaska and Anastasia Angelopoloulou, are currently studying the small Vathi quarry on Tinos, looking not only to understand its workings and diachronic use history, but also to use geofingerprinting techniques to trace the destinations of its marble, thus contributing to our understanding of how smaller quarries were integrated into the supraregional marble distribution network.

This collection of papers ends with *Components as a Possible Enabler of 'Hobby' Crafters in the Mycenaean World*, which applies the intra-cross-craft approach to Mycenaean material culture to test my hypothesis that hobby crafting was practised by elites in ancient societies. Recent research has challenged the predominant belief that hobby crafting is a specifically modern phenomenon, meaning that archaeologists should now consider this possibility when discussing past material culture production. After using modern hobby crafting to establish its basic technical and social framework, the *chaîne opératoire* for Mycenaean gilded glass ornament production, a strikingly distinctive industry with several unusual features, is examined to see if it was compatible with the targeted involvement of elite 'hobby crafters'.

Acknowledgements

The intra-cross-craft analytical framework is not intended to replace the more traditional cross-craft approach, but to enhance it. On the one hand, it can be seen as an adjunct to the latter, placing the spotlight on linkages *within* as well as *between* industries, thus enabling a better understanding of certain aspects of past production using what is already a powerful and broadly applied theoretical tool. On the other hand, the need for a specific intra-cross-craft approach may be considered symptomatic of a discipline that is still constrained by the imposition of modern categories of thought. Whilst this is to be expected, as the nature of the archaeological record makes it impossible not to specialise to some degree, that certain branches, like textile archaeology, have implicitly taken an intra-cross-craft approach demonstrates that continuing to forge our own linkages between archaeological specialisms is key to obtaining a better understanding of past production.

Finally, I would like to thank the organisers of the Third Conference of the Faculty of Archaeology at the University of Warsaw: 'Przeszłość ma przyszłość!/The Past Has a Future!', Michał Przeździeck and Marcin Wagner, for agreeing to include the workshop as one of the sessions and for all the support they gave during the conference. Thanks are also due to the Światowit editors for providing the proceedings with this wonderful home and their continued support throughout the publication process. I am deeply indebted to Dr Christina Clarke, from the Australian National University at Canberra, who not only engaged in detailed discussions with me about the concept but also encouraged me to take it further, with the workshop being a direct result.

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Intra-Cross-Craft Interaction and Cross-Craft Interaction in the Architectural Domain from the Bronze Age to Archaic Period in Mainland Greece[1]

Abstract

This paper examines the evidence for intra-cross-craft and cross-craft interaction for architectural innovations in mainland Greece from the Early Bronze Age to the Archaic period. Ceramic roofing tiles of the Early Bronze Age, Late Bronze Age, and Archaic period are given particular focus due to their long history in the region and their unmistakable materialisation of both forms of interaction. Following a discussion of this case study, a survey of architectural innovations during the study period is presented. The survey largely confirms the observations about the pace, visibility, and influences on both intra-cross-craft and cross-craft interaction that were noted for the ceramic roofing tiles. It shows that intra-cross-craft interaction never seems to occur without cross-craft interaction, and that the latter was often obscured in the final appearance of the architectural feature; the same is not true for the contributions from non-architectural craftpersons.

Keywords: Greek architecture, architectural innovation, clay building materials, intra-cross-craft interaction, cross-craft interaction, Aegean prehistory, Greek archaeology

Introduction

In most pre-modern societies, non-elite, domestic structures were typically built by the people living in them, often with the help of their kin or community. This was most likely true in mainland Greece in the Bronze and Early Iron Age (Table 1).[2] The typical vernacular structures of these periods were stone-and-mud brick constructions with flat or pitched roofs (Fig. 1).[3] Although rather modest in appearance, such structures required a diverse set of building techniques and materials. Stones were first collected and stacked in a deliberate manner to form the solid wall socles. Next, hundreds of mudbricks were mould-formed, sun-dried, and stacked on the socles. Timber was then collected, shaped, and arranged to create frames for the windows/doors, ceiling, and roof. Only after this were the roofing materials collected, processed, and arranged. To ensure a longer lifespan for the building, lime or mud plaster was prepared and applied to the walls. Finally, any fixed or semi-fixed features, such as clay bins or hearths, were constructed in place.

Of course, many of the tasks were not unique to a particular architectural feature or the architectural domain specifically. For instance, the shaping of timber was necessary for various other architectural elements, as well as outside crafts, such as furniture or wooden toolmaking. Thus, typical stone-and-mudbrick vernacular constructions incorporated both cross-craft and intra-cross-craft interaction.[4] Unfortunately, for anyone studying such craft interactions, however, the specific field in

[1] I would like to thank Stephanie Aulsebrook and the University of Warsaw for inviting me to speak and present my paper in this volume. I also thank the Greek Ministry of Culture and the American School of Classical Studies at Athens for facilitating and/or permitting my visits to numerous archaeological sites and collections of ceramic roofing tiles.

[2] Jazwa 2016.

[3] See, among many others, Fagerström 1988; Darcque 2005; Wiersma 2014; Jazwa 2016; 2021.

[4] For definitions and discussion of these terms (along with references), see Aulsebrook's (this volume) introduction to this special issue.

Table 1. The absolute and relative chronology of Mainland Greece during the study period. All dates approximate and BC.

Early Helladic (EH) = Early Bronze Age	
EH I	3100–2650
EH II	2650–2200
EH III	2200–2100
Middle Helladic (MH) = Middle Bronze Age	
MH I–III	2100–1700/1600
Late Helladic (LH) = Late Bronze Age	
LH I	1700/1600–1600/1500
LH II	1600/1500–1410/1390
LH IIIA	1410/1390–1315/1300
LH IIIB	1315/1300–1190
LH IIIC/Submycenaean	1190–1000
Early Iron Age (EIA)	
Protogeometric (PG)	1000–900
Geometric (G)	900–700
Archaic	700–479

which many of these tasks, especially the very basic ones such as the retrieval and stacking of stones in deliberate arrangements, were initially developed is unlikely to ever be ascertained. Similarly, it is impossible to tease apart the precise origins and direction of the interaction among crafts due to the ubiquity and long history of vernacular architecture and its associated activities. More promising contributors to such studies are the numerous innovations and additions to the architectural domain that occurred throughout the Bronze and Early Iron Ages in mainland Greece. For instance, it is much clearer when and where the ceramic tiled roof was invented and developed within mainland Greece.[5] Careful study of this and other architectural innovations can, therefore, reveal how these technologies relied upon, added to, or altered techniques and methods that had already applied to other areas of construction (intra-cross-craft interaction) and/or incorporated techniques from other craft domains of the period (cross-craft interaction).

Although several different architectural features and innovations have been incorporated into one final product (the building), the innovations can be studied individually as additions to vernacular traditions. Not only were the innovations never accompanied immediately by a complete revision of fundamental building techniques and materials, but the building construction never relied entirely upon one or more specialist craftspersons.

Fig. 1. A modern mudbrick structure in Greece that possesses many of the features of the prevailing vernacular methods in the region (photo by K. Jazwa).

[5] Wiencke 2000; Marzolff 2017; Jazwa 2018; 2020.

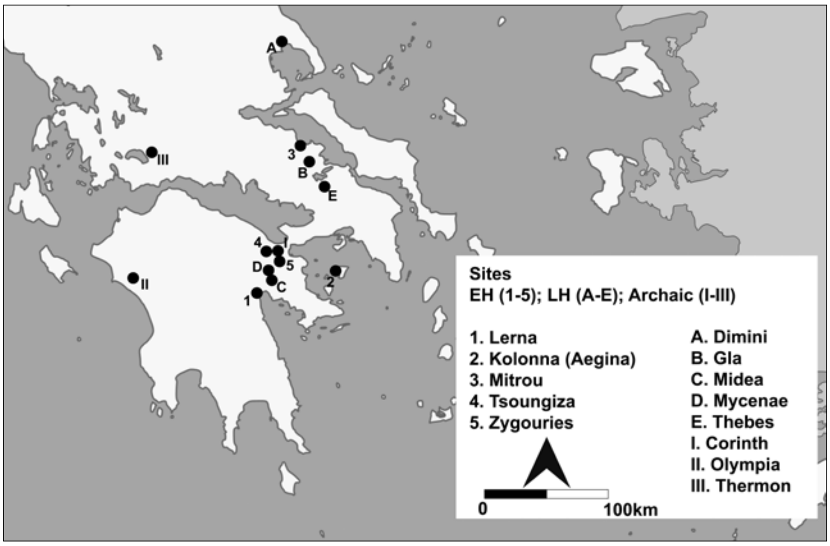

Fig. 2. A map of mainland Greece and location of sites mentioned in the text (compiled by K. Jazwa).

The production of other elements of the building (*e.g.*, stone foundations, mudbrick walls, timber framing) were accessible to and practised by nearly every inhabitant of mainland Greece. This is true even for elite or monumental constructions of these periods. Only with the construction of the Temple of Artemis at Kerkyra in 580 BC, a building made almost entirely of worked stone, does a substantial deviation from the vernacular, such that non-craft specialists were almost entirely unnecessary in its construction, appear in the study area.[6]

In this paper, the variety and pace of intra-cross-craft and cross-craft interaction evident in mainland Greek architecture of the Early Bronze Age to the Archaic period are examined and compared among periods. The invention of ceramic roofing tiles in the Early Helladic (EH), Late Helladic (LH), and Archaic periods is first offered as an illustrative case study. Following this discussion, other architectural innovations/additions from the study period are surveyed and the apparent intra-cross-craft and cross-craft interaction noted. The results attest to the importance of both types of interaction, and demonstrate that they were equally stimulated during periods of increasing socio-political complexity and depressed during others.

Ceramic Roofing Tiles

Ceramic roofing tiles were independently invented in mainland Greece on three separate occasions: the EH period, Mycenaean (LH) period, and the beginning of the Archaic period (Fig. 2).[7] In the first two instances, the technology was widely used for several centuries before being abandoned; only after the third episode of invention did the technology endure. In this section, each episode of roofing tile use is briefly described, and the outside craft and architectural influences are emphasised.

EH Tiled Roofs

EH ceramic roofing tiles are thin, rectilinear slabs of clay *c.* 20–25 x 20–25 x 1–2 cm. They were occasionally accompanied by similarly sized schist roofing tiles. All tile types were arranged in a shingle-like arrangement on the buildings' roofs (Fig. 3).[8] This roofing system appears to have been developed at the end of the EH I period and continued to be constructed during EH II, before it became a casualty of the accompanying sociocultural changes and transition to EH III.[9] The tiles roofed a variety of structures including the period's corridor houses, fortifications, and domestic buildings, but they never became the primary roofing method in mainland Greece nor were they adopted outside the mainland. Instead, vernacular traditions – pitched thatch and/or flat, unfired clay roofs – persisted.[10]

Although EH ceramic roofing tiles appear to have been produced without a single, standard production method, the *chaîne opératoire* of one subgroup, *i.e.* those produced by the mould-and-cut method, has recently

[6] For earlier monumental construction methods, materials, *etc.*, see Barletta 2001.

[7] For an overview, see Winter 1993, 8–10; Sapirstein 2008, 29–78.

[8] Caskey 1954; Wiencke 2000, 197–307; Marzolff 2017; Jazwa 2018; 2020.

[9] Jazwa 2018. For this period of transition, see Caskey 1960; Forsén 1992; Maran 1998; Weiberg, Finné 2013.

[10] Jazwa 2020.

Fig. 3. A schematic representation of typical EH II ceramic roofing and the arrangement of these tiles on the roof (drawing by K. Jazwa).

been reconstructed.[11] This technique is recognised among several assemblages, including Mitrou's, Tsoungiza's, Lerna's, Tiryns's, Kolonna's, and Zygouries's. With this, prepared clay paste was first spread in a long, narrow mould, before individual tiles were cut by making single slices through the narrowest width of the clay pad; these formed tiles were then dried and fired. Such a production process demonstrates clear interaction with other tasks in both the architectural repertoire (mudbrick making) and non-architectural craft traditions (pottery production). Whereas the latter is evident in the preparation of the refined clay paste and expert firing of the tiles, the former is manifest in the use of a mould for the forming. The addition of chopped organic (straw/grass/chaff) temper to the clay paste and the use of a specially prepared production surface covered by a suitable parting agent, such as grass, straw, or sand, are also shared with mudbrick making, along with another architectural feature of the EH period: monumental clay hearths.[12] Consequently, the development of the ceramic roofing tiles reflects an entanglement of multiple influences, including both cross-craft and intra-cross craft interaction.

LH Tiled Roofs

Nearly a millennium after the EH tiled roof technology was abandoned, the LH IIIA inhabitants of mainland Greece again turned to fired clay for roofing some buildings, but this version was considerably different in form. Unlike the EH ceramic tiled roofs, the Mycenaean roofing system required two distinct varieties of ceramic roofing tiles: pan and cover tiles (Fig. 4).[13] The flat pan tiles have walls on two parallel sides (*c.* 4–8 cm) and are slightly longer (*c.* 50 cm) than they are wide (*c.* 40 cm) with the width tapering at one end. The cover tiles are semi-cylindrical, *c.* 45–60 cm long, also with a tapered width. The roof itself was formed with the pan tiles first covering the roof surface such that the wall of one pan tile abutted a wall of another pan tile on either side. The narrower ends of the tiles then slotted into the wider end of the tiles in the row below them. With the pan tiles thusly arranged, cover tiles were placed over the pan tiles' abutting walls.

Unfortunately, the architectural contexts of the Mycenaean roofing tiles are not as well known as in the EH period, because most LH assemblages are rather small in quantity and were from disturbed contexts.[14] While it is true that fragments have mostly been recovered from the period's more substantial settlements, such as Mycenae, Midea, Dimini, Gla, and Thebes, the tiled roof does not appear to have been reserved for the primary palatial or monumental structures at the site. At Thebes, for instance, tiles were found distributed throughout the Kadmeia and associated with a storage shed, among other structures.[15] During this period, the tiled roof appears to have been especially popular in Boeotia and the Argolid. It also managed to survive the initial palatial collapse at the end of LH IIIB, but did not endure to the end of the LH IIIC period.

Like the EH tiles, the published evidence for the Mycenaean tiled roof attests to the influences from outside

[11] Jazwa 2018.

[12] For Bronze Age mudbricks, see: Darcque 2005, 75–78; Devolder, Lorenzon 2019; Lorenzon 2021; for parting agents, see: Sapirstein 2008, 100–102, 269–270, 340; 2009; Jazwa 2018; and for EH hearths, see: Galligan 2013.

[13] Iakovidis 1990; Jazwa 2020; 2021; Aravantinos *et al.* 2020.

[14] There was previously some debate about the proper identification of this material as roofing tiles (for a summary of this debate, see Sapirstein 2008, 29–78). This was largely the result of the small number of fragments found at sites with LH roofing tiles, and the fact that sometimes cover tiles were found without pan tiles and vice versa (Aravantinos *et al.* 2020 count at least 11 sites with both tile types). Recent discoveries at Thebes (Aravantinos *et al.* 2020) and Eleon (Jazwa 2020), however, prove that the ceramics were, indeed, for tiling roofs, due to their abundance, locations of deposition, and weathering marks. With these discoveries, the debate about LH ceramic roofing tiles has largely ceased.

[15] Aravantinos *et al.* 2020.

Fig. 4. A schematic representation of typical Mycenaean ceramic roofing and the arrangement of these tiles on the roof (after: Aravantinos *et al.* 2020, fig. 22).

crafts and other aspects of architectural construction. Both the clay paste and firing of the cover tiles, for instance, demonstrate a close affinity with contemporaneous pottery of the period; the manufacture of these tiles also borrowed other pottery techniques, such as the initial forming with clay coils and finishing on the wheel. In these regards, cover tile construction resonates with another form of well-fired architectural ceramics, clay chimneys.[16] This is apparent in both the shape and forming methods, as both required the initial forming of a coil-built tube and wheel finishing. However, the chimney (slightly wider and thicker) remained cylindrical, while individual cover tiles were formed by cutting the cylinder in half lengthwise prior to firing and became narrower towards one end.[17] All the chimneys cited by Pascal Darcque's survey of Mycenaean architecture date to LH IIIB or later, and thus appear to post-date the earliest Mycenaean roof tiles (LH IIIA).[18] Although there has yet to be a thorough study of Mycenaean chimneys, it therefore appears that the direction of influence was from ceramic roofing tiles to the chimneys. In any case, the cover tiles (as well as the chimneys) clearly reflect cross-craft interaction and inter-cross-craft interaction.

Compared to the Mycenaean cover tiles, pan tile production was rooted in more vernacular mud-based architectural constructions than the pottery industry. Mudbrick making, for instance, would have been helpful for any clay pads initially formed with a mould. Additionally, the clay paste used for the pan tiles includes much coarser inclusions, organic temper, and parting agents, just like mudbricks. The clay paste and the forming methods also have analogues in a class of low-fired, prehistoric clay objects: 'utilitarian trays' or 'clay bins'. This type of semi-fixed furniture consisted of a rounded slab of clay, with a wall on at least one side turned upwards.[19] The low firing temperature, handmade appearance, and coarse fabric suggest that these utilitarian trays were probably built by non-specialists. Thus, Mycenaean pan tiles are also the product of both cross-craft and intra-cross-craft interaction.

Archaic Tiled Roofs

Approximately four centuries after the abandonment of the Mycenaean roofing tiles, in the 7th century BC, the tile roofing system was again invented in mainland Greece. This version was initially given to monumental temples, before being deployed on civic structures and domestic buildings.[20] The various ceramic roofing tile systems developed in this period were quite diverse in form, but nearly all feature an arrangement that resembled the Mycenaean system with an appearance (if not use) of distinct pan and cover tiles.[21] This is exemplified in the two earliest-known roofing systems. The seemingly older of the two, the mid-7th century BC roof 1 from Olympia, employed separate pan and angled cover tiles, much like the Mycenaean predecessor (Fig. 5).[22] The Protocorinthian roof from Corinth primarily consisted of 'combination tiles', each of which included a cover tile attached to the pan tile (unlike the Mycenaean system with separate pan and cover tiles) that interlocked with other combination tiles to create a contin-

[16] Shear 1968, 11; Nelson 2001, 66–70; Darcque 2005, 81; Adrimi-Sismani 2014, 169–170, 232–233.

[17] Jazwa 2020; 2021.

[18] Darcque 2005, 81.

[19] Mersereau 2020, 458–466; Jazwa 2022.

[20] For overviews, see Winter 1993; Sapirstein 2016.

[21] Winter 1993; Skoog 1998, 21–44; Sapirstein 2016.

[22] Sapirstein 2016, 41.

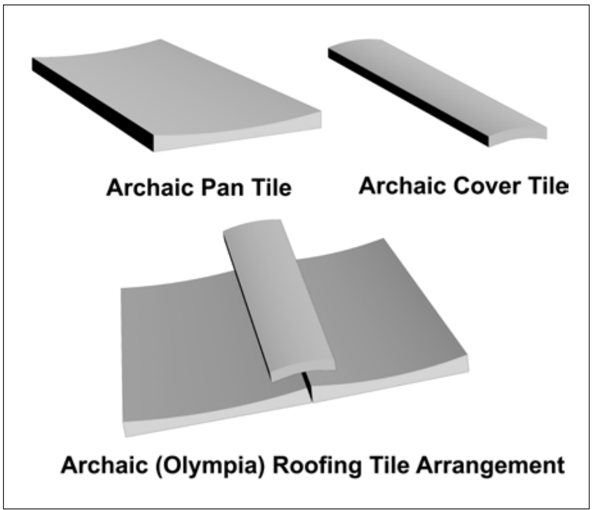

Fig. 5. A schematic representation of an early Archaic ceramic roofing tile (after Roof 1 from Olympia) and the arrangement of these tiles on the roof (after: Sapirstein 2016, fig. 4.1).

uous roofing surface.[23] The Laconian tile system from later in the same century was again different, in that it employed both semi-cylindrical cover and pan tiles.[24]

Archaic tiles of all forms employed ceramic specialists, most likely potters, for the preparation of the clay paste and firing. Philip Sapirstein's study of the Protocorinthian roofing system also documented the essential use of a mould for much of the forming of the combination tiles at Corinth. He thus concluded that potters, coroplasts, and/or sculptors all played important roles in the development of the technology.[25]

In addition to this cross-craft interaction, the tiles appear to reflect interaction with other areas of the architectural domain. During the late 7th and 6th centuries BC, ceramic architectural elements, most of which had decorative functions, greatly proliferated in number, variety, and type. There are, for instance, painted terracotta plaques (Temple of Apollo at Thermon), acroteria, and antefixes.[26] The shared medium of fired clay thus indicates the presence of intra-cross-craft interaction for the ceramic architectural constructions of the period. It is even possible that the ceramic tiled roof had an important role in the proliferation of intra-cross-craft interaction in architecture, as the Archaic-period use of ceramic roof tiles appears to predate those other forms of architectural ceramics.[27] Perhaps, the extensive use and deployment of ceramics for the new tiled roofs helped set a precedent for involving ceramic (or other) specialists in the production of monumental civic architecture. The subsequent additions then expanded upon the practice and repertoire.

Sapirstein has similarly shown that the Archaic ceramic tiled roof was an important agent of intra-cross-craft interaction in cut-stone masonry. He identified the use of band anathyrosis in tiles that predates the first use of this technique in worked stone.[28] This arose as one of many "solutions to the challenges of manufacturing and installing tiles inspired important innovations subsequently incorporated as masonry techniques".[29] Thus, intra-cross-craft interaction can also be shown to have incorporated different materials.

Assessing the Roofing Tile Systems

Though different in form and arrangement, the ceramic tiled roofs of all three periods were important agents of both cross-craft and intra-cross-craft interaction. For the two prehistoric episodes, the technology was primarily rooted in vernacular technologies while leveraging skills from pottery production. Thus, almost any individual living in mainland Greece could have contributed significantly to the tile-making process; however, entire roofs could not have been built without the help of outside specialists. In this respect, the Archaic period's ceramic tiled roofs are different, because they appear to have primarily relied on ceramic specialists (*i.e.* potters and/or coroplastic artisans). They were also not solely connected to or influences upon other ceramic architectural innovations, but may have influenced stone construction as well.

Despite the important influence of other vernacular architectural traditions in the development of the prehistoric ceramic tiled roofs, it is noteworthy that this influence would not have been detectable when the roofs were fully assembled. The specific production techniques that were shared with vernacular architectural methods, such as mould-forming (mudbricks), would not have been detectable with the roof fully assembled.[30] The same is true for the distinctive features that the Mycenaean pan tiles shared with the utilitarian trays (*i.e.* the walls) which would have been entirely covered by the refined cover tiles. Instead, the material, *i.e.* fired clay, would immediately have been associated with an outside craft activity (pottery) due to the absence of similar exterior architectural features (notwithstanding the less visible chimneys and drains).

Thus, in all periods, the materialisations of the intra-cross-craft interactions that contributed to the development of the roofing tile technology were largely hidden

[23] Winter 1993, 12–18; Sapirstein 2008; 2009; 2016.
[24] Winter 1993, 95–109; Skoog 1998; Sapirstein 2016.
[25] Sapirstein 2008, 328–331.
[26] Winter 1993; Skoog 1998, 29–40; Barletta 2001.
[27] Winter 1993.
[28] Sapirstein 2008, 325–328; 2016, 56–57.
[29] Sapirstein 2016, 56.
[30] Jazwa 2018.

in the architectural innovation's final form. The contributions of specialist craftpersons from other domains, however, were highlighted by the materiality of the feature and, in some cases, the general form (*e.g.* curved clay). Because those ceramic specialists had not previously participated in architectural construction in any of the three episodes, those contributions would have been noted as a contrast to the more familiar clay-based architectural elements (*e.g.* mudbricks) that almost everyone had experience making.

Surveying Intra-Cross-Craft and Cross-Craft Interaction

In this survey, the evidence for intra-cross-craft interaction and cross-craft interaction among the architectural innovations of the Bronze and Early Iron Ages are presented (Table 2). In doing so, it provides insight into the potential influences stimulating such interaction and the reception of the intra-cross-craft interaction for architectural constructions. Although this overview aims for extensive coverage, it certainly does not claim to be exhaustive.

Early in the study period, the evidence for both forms of craft interaction is rather limited. Roofing tiles are among the few architectural innovations that clearly demonstrate both. Nevertheless, this single innovation was quite widespread in the EH period and used for various building types, including domestic architecture, fortifications, and large communal buildings, like corridor houses. While EH ceramic roofing tiles have already been discussed, the schist varieties may also reflect at least some cross-craft interaction, because some trained stone-workers may have been used to shape and form holes in the rarer schist roofing tiles. However, it remains to be determined if such contributions were necessary.

The appearance of both the ceramic and schist roofing tiles coincided with a growth in settlements, craft specialisation, and sociopolitical complexity. Monumental architecture (*e.g.*, corridor houses, fortifications) also became more common, and roofing tiles were associated with several of these monumental EH buildings. This development, therefore, attests to a desire to elaborate upon the established vernacular for communal buildings at least. However, the distribution of roofing tiles at some sites indicates that the architectural innovations (and thus the intra-cross-craft and cross-craft interaction) were not reserved for the monumental buildings, but were more widely accessible.

After the abandonment of the tiled roof, evidence for architecturally innovative features (and thus related intra-cross-craft and cross-craft interaction) is absent for many centuries (EH III–MH II). This coincided with the almost exclusive construction of modest architecture and the presence of smaller communities.[31] While there were certainly craft specialists in these periods, such as potters, it is unlikely that there were largescale industries in any domain.

All this changed by the MH III period (if not slightly earlier), alongside the emergence of local elites in several regions of mainland Greece.[32] The increasing

Table 2. Non-vernacular architectural features that demonstrate evidence for cross-craft and intra-cross-craft interaction.

	Cross-Craft	Intra-Cross-Craft
EH	Ceramic Roofing Tiles Schist Roofing Tiles	Ceramic Roofing Tiles Schist Roofing Tiles Ceramic Hearths
EH III–MH II	–	–
MH III–LH II	Ashlar/Cut-Stone Masonry Painted Plaster	Ashlar/Cut-Stone Masonry(?) Painted Plaster
LH III	Cut-Stone Masonry Carved/Sawn/Drilled Stone Painted Plaster Ceramic Roofing Tiles Half-Timber Masonry Ceramic Chimneys Ceramic Drains	Cut/Worked Stone(?) Painted Plaster Ceramic Roofing Tiles Half-Timber Masonry Ceramic Chimneys Ceramic Drains
PG–G	–	–
Early Archaic	Ceramic Roofing Tiles Acroteria/Antefixes/*etc.* Wall/Plaque Painting Cut-Stone Masonry	Ceramic Roofing Tiles Acroteria/Antefixes/*etc.* Wall/Plaque Painting Cut-Stone Masonry

[31] Wiersma 2014; Jazwa 2016.

[32] See, for example, Wright 2006; also, discussions in Wiersma 2014; Jazwa 2016.

construction of elite and monumental architecture was met by new architectural innovations and the participation of a wider variety of outside specialists for architecture. For the first time in mainland Greek (pre-)history, for example, cut-stone masonry was incorporated into the region's architecture.[33] This is evident at Pylos with the numerous ashlar blocks found in the later Mycenaean palace, but assigned to an earlier structure on the site.[34] This ashlar masonry was probably influenced by Minoan Crete where the technique had already been in use.[35] While stone had been employed for architectural construction in mainland Greece for millennia before the appearance of ashlar, the methods used for the production of ashlar masonry did not otherwise have clear analogues in the architectural sphere. Instead, the relevant production knowledge most likely had precedent in other crafts, such as the construction of stone vessels. Due to the external origin of the building method, such craft interaction must have occurred in an area outside mainland Greece and long before the technique arrived there.

At roughly the same time (*c.* MH III), representational wall painting on plaster was introduced to the Greek mainland, probably from Minoan Crete.[36] This innovation is more clearly the product of cross-craft and intra-cross-craft interaction. Regarding the former, the painting itself probably had predecessors in established visual arts such as decorated ceramics and painting of stone vessels.[37] At the same time, the addition of paint to plaster intersects with established methods of plastering (lime or mud plaster) walls and floors that had existed in mainland Greece and elsewhere for millennia.[38] It is, however, unlikely that this interaction initially occurred in mainland Greece, but in Minoan Crete, Egypt, or otherwise, where the technology was initially developed and similar vernacular methods were also in use.

During this early Mycenaean period, both forms of craft interaction were rather limited in their distribution and only sparingly used in the mainland. They are exclusively found in monumental and/or elite structures, particularly at locations that later became palace sites. They were also shown to have been brought in from outside where the relevant interactions (cross-craft and intra-cross-craft) initially occurred. Thus, this period cannot necessarily be classified as one in which cross-craft or intra-cross-craft interaction were stimulated in the architectural domain. Instead, it was driven by the adoption of foreign architectural features that happened to have such influences already "built in".

This pattern is not true in the subsequent period, LH III. The first subphase, LH IIIA, coincides with an acceleration of elite, intra-regional competition and, in some areas, the first regional palatial kingdoms. These are manifest in the construction of massive elite and palatial structures, such as palace complexes and monumental tholos tombs.[39] During this mature Mycenaean period (LH IIIA–B), new architectural innovations that materialise both intra-cross-craft and cross-craft also expanded throughout the Greek mainland, especially for those elite and palatial structures. In addition to the continued use of cut-stone masonry and painted plaster, ceramic roofing tiles were re-invented, other ceramic fixed and semi-fixed features, such as chimneys and drains, first appear, and half-timbered masonry, a technique that was probably developed in and adopted from Anatolia, was applied.[40] Used more sparingly also were other forms of stoneworking, such as sawing and drilling for constructions like the Lion Gate, that were also initially developed elsewhere but had predecessors in crafts, such as seal/gem carving.[41]

Needless to say, many of these mature Mycenaean architectural innovations were owed to outside craftspeople, and the evident cross-craft and intra-cross-craft interaction associated with them most likely occurred elsewhere. However, this is not true for most of the architectural ceramics. Ceramic chimneys and ceramic roofing tiles, for instance, reflected the ongoing influences from within the architectural domain and outside. Drains, while having antecedents in Minoan Crete, also probably leveraged the skills of established potters and/or vernacular traditions, as the general shape and/or forming methods were not too dissimilar from cover roofing tiles and utilitarian trays. This is evident among the semi-cylindrical examples from Zygouries and U-shaped

[33] Wright 1978; 2020; Blackwell 2020; Kreimerman, Devolder 2020, 41–45.

[34] Wright 1978; 2020; Nelson 2001.

[35] Wright 2020; Blackwell 2020, 215; Kreimerman, Devolder 2020.

[36] For Mycenaean wall painting see, among others, Immerwahr 1990; Tournavitou 2017; Egan 2021. For the Minoan influence and/or the early date, see Immerwahr 1990, 105–146; Egan 2021.

[37] Immerwahr 1990, 17–19, 21–40.

[38] Immerwahr 1990, 11–13, 21–22.

[39] See Wright 2006, among others.

[40] Wright 2006, 28–33. Half-timber masonry elsewhere: Dakouri-Hild 2001, 89–92; Nelson 2001, 154–169.

[41] Wright 2006, 33–34; Blackwell 2014.

examples from Pylos and Dimini.[42] Half-timbered masonry, which did not necessarily require specialist skills and was introduced from outside the Greek mainland, probably drew upon the experience and skills already present among the workforce engaged in building production as well. Indeed, almost any resident of mainland Greece would have had experience felling trees, preparing timber for domestic constructions, and mixing clay mortar. In short, the mature Mycenaean period represents an acme in architectural innovations that owed much to cross-craft and inter-cross-craft interaction, even if these interactions did not always occur in mainland Greece. The application of these innovative features was largely limited to monumental, elite constructions.

Following the collapse of the palaces and the LH IIIC period, there was again an absence of architectural innovations and new intra-cross-craft and cross-craft interaction in this domain. This occurred alongside a contraction of settlement/population numbers, wealth, and external contacts.[43] Only a few monumental or large-scale constructions, such as the Heroön at Lefkandi, were built during this period, and none included new architectural features *per se*.[44]

It was not until the emergence of the *polis*, population expansion, and reinvigorated external exchange that monumental constructions became more common and architectural innovations again proliferated. Such innovations were primarily in two media: ceramic and stone. They were first limited to monumental civic constructions, such as temples, but were rather swiftly adopted for other structures, including domestic. Unlike in the Mycenaean period, however, few if any of these architectural features appear to have been primarily introduced from abroad.

Assessing Craft Interaction

Overall, this survey demonstrates that architectural innovations that materialise intra-cross-craft or cross-craft interaction were not evident during the entirety of the study period. Both forms of interaction were exclusively stimulated during times of elevated sociopolitical complexity, elite/monumental building, and wealth. In fact, monumental architecture appears to have been an important conduit for such interaction in these periods. This is equally true whether these constructions were elite structures (Mycenaean palaces), communal buildings (EH corridor houses), or civic/religious buildings (Archaic temples). Of course, the architectural innovations were not always limited to such monumental buildings (except, arguably, in the Mycenaean period). However, in at least the second two instances, they appear to have been initially developed for monumental constructions.

In the periods of lesser complexity and fewer monumental constructions, both forms of interaction were significantly depressed. Such a decline cannot be attributed to an absence of knowledgeable labourers because the essential skills that were incorporated into the production of these innovations were retained within the origin crafts of the specialists. Painting, for instance, endured among potters between the Mycenaean period and the Archaic period and, though ceramic-tiled roofs ceased to be built for long periods, clay continued to be worked and fired by potters. This suggests that the presence or absence of such interaction in the architectural domain was driven by cultural, political, social, or economic factors.

At the same time, the survey shows that intra-cross-craft interaction always occurred in tandem with cross-craft interaction in the architectural domain. For instance, the EH ceramic roofing tiles were equally influenced by the mudbrick traditions of vernacular architecture and the specialist pottery industry. Whether the architectural innovations were initially developed in Greece or not, in no case do they indicate intra-cross-craft interaction without complementary contributions from outside craftpersons.

The intra-cross-craft interaction, however, rarely appears to have been highlighted in the final construction. This contrasts with the cross-craft interaction which, in many cases, was quite apparent. For instance, the materiality, form, and painted decoration of all three periods' ceramic-tiled roofs would immediately associate the technology with pottery production, but not mudbricks or low- or unfired clay furniture. This suggests that the ties to other craft specialists were more appealing than any novel application of established architectural methods within this new feature.

That the efforts of the outside labourers had an important aesthetic or visual function is clear from the other innovations as well. The wall paintings, for instance, provided a richly decorated interior wall surface that unmistakably linked them with non-architectural artisans. Ashlar courses also lent additional visual appeal to the wall courses with the regular and neat appearance of the blocks. During the Mycenaean period especially,

[42] Blegen 1928, 28–38; Nelson 2001, 60–66; Shaw 2004.
[43] Murray 2017.
[44] Fagerström 1988; Jazwa 2016.

the influences – if not direct contributions from foreign craftpersons – would have been on full display with these features. Consequently, these buildings materialised the inhabitants'/communities' access and ability to marshal this specialist labour for cross-craft interaction.

Understandably, the products of intra-cross-craft interaction typically lacked the same aesthetic function. A clay bin is unlikely to have been considered as visually appealing or distinctive as a figural wall painting. This is owed in large part to the accessibility associated with the origin traditions, their vernacular origins, and their prevalence within domestic contexts. Indeed, the intra-cross-craft influences reflected methods and abilities that were achievable by most and resonant with many vernacular constructions of the period. Consequently, they were probably far less impressive when placed on a building. The intra-cross-craft interaction may have simply been considered a means to an end and, though integral to the design, an incidental component of the construction process.

Conclusion

In short, intra-cross-craft interaction for architectural innovations of the Bronze and Early Iron Ages of mainland Greece appears to have been fundamentally tied to cross-craft interaction and monumental architecture. Although intra-cross-craft interaction never appears without cross-craft interaction, the recognition of the former was often hidden in the final appearance/placement of the new architectural feature. The opposite, however, is true for cross-craft interaction. This is most likely because most individuals had experience with vernacular constructions and, thus, the contributions of related crafts/skills to the new architectural component would have been less impactful than those of the skilled craftpersons. Thus, intra-cross-craft interaction appears to have fundamentally contributed to most new architectural features of the Bronze and Early Iron Ages, but it was not something that was advertised.

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The Metals' Family Tree and Their Separate Branches: an Experiential Journey

Abstract

Metals have been integral to people's lives for several millennia. We interact with them daily in many forms to fulfil a wide range of needs, from food preparation or elaboration of attire, to architectural components or means of transportation. We take for granted that one material meets these distinct challenges, but discovering metal's versatility has only been achievable through long-term engagement over a period of millennia. This enabled craftspeople to learn and understand their special characteristics, or properties, which both facilitate and constrain usage, with each metal having its own unique combination of properties. Due to this, craftspeople frequently employ multiple metals for a single artefact, melding together a desired package of properties. The significant differences between the metals and their recurrent use in combination thus calls for an intra-cross-craft approach.

Past metal production can only be fully understood by comprehending these properties. This knowledge comprises elements that can be transmitted discursively, but also those that can only be transmitted non-discursively, the latter being impossible to communicate in full without direct experience, which can be difficult to acquire. This paper proposes methods through which such direct experience of the properties of metals can be obtained, by inviting readers to participate in simple experiential activities using common household items. These properties are then discussed in an intra-cross-craft setting, using case studies to demonstrate how and why different metals are used together and the implications of these technical practices.

Keywords: metal, metal properties, metal production, intra-cross-craft, experiential, non-discursive knowledge transmission

Introduction

You are about to embark on a journey that explores the differing properties of metals through hands-on experience, which is designed to provide a taste of how craftspeople learn to work with metal by their acquisition of knowledge, both discursively, but especially non-discursively. Therefore, before settling down comfortably to read this paper, we advise you to have to hand as many of the following items as possible: a blunt pencil topped with an eraser, thick aluminium foil, a piece of cardboard, scissors, two stainless steel teaspoons, an empty can, a plastic beaker or old mug, a piece of paper, a collection of coins (both silver and copper if possible), a pen knife, a metal paper clip, a spring-loaded ballpoint pen, sellotape, a lighter or candle+matches, a pair of glasses, a weak acid (such as a fizzy soft drink, like lemonade or cola, vinegar, or lemon juice) mixed with a little table salt, some chocolate wrapped in foil and finally, something that can be used to make a soft surface (old newspaper, piece of felt, etc.).

Metals are all around us. We take for granted their special characteristics that contribute to the environment in which we live. Throughout the majority of history and prehistory, the family of metals have been an intriguing and practical part of daily life for human families. Despite this, if you asked a typical person what their definition of metal would be, chances are the answers you would receive would resemble "shiny, hard, heavy, light, strong, stiff, bendable material". Metals, therefore, seem inherently contradictory: hard but flexible, strong but fragile. Metals are also constantly changing, through their interaction with their environment. Yet all of this is due to specific characteristics, or properties, that belong to the metal family.

Understanding these properties is vital to the successful production of objects that incorporate metal. The characteristics of metal can both help and hinder the design and manufacture of a desired artefact, and they guide every step of the decision-making process. Any craftsperson, past or present, must not only understand these properties of metals, but also learn how to read, respond to, and work with them for every single individual piece of metal with which they interact. These skills of observation are vital for crafting artefacts and involve multiple senses; through engaging with metals, craftspeople are trained to look for certain signs, to feel and to hear the metal, in order to achieve their desired outcome.[1] Any discussion of metal-crafting in past societies is then, by definition, situated in the realm of sensory archaeology.[2]

Moreover, any discussion of metal-crafting and the use of metals in past societies must, ultimately, rest upon these properties of metal;[3] even sociopolitical- or symbolic-centred debates are founded on them. It has been posited, for instance, that the immutability of gold can help explain its attractiveness and the development of certain specific symbolic associations, such as its links to the divine.[4] The fact that pure gold does not tarnish is a distinctive characteristic of this metal, noticeably distinguishing it from other metals such as silver or iron, and is due to one special property that it shares with few other elements: exceptionally low chemical reactivity to its environment. However, there is little to no reason why archaeologists, along with the majority of the population, need to think about these properties of metals on a day-to-day basis, because we usually encounter such objects after they are finished, in other words after all the production decision-making is complete. We express no surprise that the material used to create the skin of an aircraft, aluminium, also finds a use in the kitchen as a food-wrapping solution; such choices of which metal to use are presented to us as self-evident, when they in fact emanate from the millennia-long engagement between human communities and the family of metals.

Given that metal-crafting in particular, both as a sole focus and in cross-craft studies,[5] has remained an important topic of study for archaeologists across many decades, awareness of these properties of metals has instead been acquired by individual specialists, to a varying degree, through dedicated material science textbooks,[6] ancient technology publications,[7] and experimental[8] and experiential[9] archaeology. The special significance of

[1] Kuijpers 2015.

[2] See Skeates, Day 2020 for a recent overview of sensory archaeology as a discipline and what this perspective can achieve, particularly by moving beyond the Western model of the five senses.

[3] This paper concentrates on the importance of the differing properties of metal for secondary metalworking, *i.e.* the manufacture of metal artefacts (metal-crafting), rather than primary metalworking, the obtaining of metal. Of course, the latter is also significantly influenced by the differing properties of metal, especially their degree of reactivity with their environment.

[4] For example, Betz 1995, 19; Whittaker 2008, 94.

[5] For example Nosch 2016, although the majority of cross-craft studies reference metal-crafting as an inspiration for other crafts, rather than exploring the impact of cross-craft interaction on metal-crafting itself.

[6] For example Brady *et al.* 2002; Cardarelli 2018. The majority of these are intended for general use, meaning that they concentrate on modern forms and uses of metal, but see, for example, Scott 2012; 2013; Notis 2014 for handbooks aimed at an archaeometallurgical audience only, as well as conservation handbooks, such as Selwyn 2004; Garside, Richardson 2021, which give information on a subset of metal properties relevant to their care in museum settings.

[7] For example Evely 1993; 2000; Hughes 1993. These publications collate information specifically useful to archaeometallurgists by concentrating on metals within past settings (sometimes referred to as 'heritage metals'), especially before the development of modern methods of metal-crafting that provide more precise control over their physical and chemical properties.

[8] There is no clear-cut boundary between experimental and experiential archaeology. However, the former tends to follow a more rigorous approach that employs standard elements of scientific methodology, such as control and isolation of variables, repetition of experiments, and integration of recording using high-quality equipment, to answer specific questions related to a technical process, whereas the latter more frequently assesses the role of people or other aspects that cannot be quantitatively measured, considering the process from a holistic perspective, and therefore the design of the experiments vary accordingly and usually follow a more relaxed protocol (Doonan, Dungworth 2013). In short, experiential archaeology is often a learning process, whereas experimental archaeology is more akin to testing. The two approaches are complementary. Experiential archaeology is often a prerequisite stage before further controlled experiments can be carried out, as it provides an opportunity to explore the range of factors relevant to a particular technical process. Recent examples of experimental archaeology investigating metal properties include Pingel 1995; Fang, McDonnell 2011.

[9] Unfortunately, experiential archaeometallurgy experiments are less likely to be published (Doonan, Dungworth 2013, 8). Recent publications that could be considered closer to experiential rather than experimental archaeology include Maragoudaki, Kavvouras 2012; Blackwell 2018.

experimental and experiential archaeology for obtaining and transmitting this knowledge has long been recognised and encouraged within archaeometallurgy, especially for primary metalworking (smelting).[10] Together, they fulfil a vital role, by allowing archaeologists to gain knowledge of the properties of metals that can only be transmitted non-discursively, information necessary for metal artefact production that cannot be communicated through words alone:[11] what exact shade of 'cherry-red' indicates that the metal is hot enough to work, or how much force is required for a 'single heavy blow'? It is worth noting that direct observation and participation also conveys and reinforces knowledge that can be transmitted discursively more effectively.[12]

Why, though, is it important for *archaeologists* to develop an understanding of the properties of metals? On the one hand, it could be argued that interdisciplinary research teams incorporating people with craft experience negates such a need, and indeed this solution is becoming increasingly widespread.[13] However, without this type of metallurgical knowledge, it is not plausible to begin designing meaningful research projects for certain forms of archaeology.[14] Moreover, lacking even a basic level of awareness, it is possible for interpretations to accidentally incorporate elementary mistakes that can have a significant bearing on the trajectory of future research. One of the most clear-cut examples stems from early experimental work on prehistoric bronze shields. The first in-depth study on this subject, published in 1962,[15] whilst a seminal and pioneering piece of research, also ingrained into the archaeological literature the belief that these bronze shields were essentially for show, and should be considered non-functional. It would come as no surprise to any smith that the thin, industrially produced copper sheet used for the shield replica was easily ravaged during these experimental tests, but they would be bemused as to why it was ever considered a suitable substitute material for the hammered bronze used in antiquity. Subsequent research using more accurate replicas[16] has demonstrated how misleading these early experiments were; however, it would take more than four decades for this interpretation to be challenged.

Furthermore, awareness of these properties and the role they play in the manufacture and use of metals opens novel research avenues that may lead archaeologists towards surprising interpretations and intriguing aspects that previously have been unintentionally overlooked. The need to employ metallurgical skill to fragment certain types of metal artefacts has relatively recently reached mainstream archaeological consciousness,[17] skill that is firmly founded on knowledge and familiarity with the properties of metals. This has considerable implications for our recognition and understanding of fragmentation as a deliberate action, replacing prior assumptions of a simple and perhaps even mindless task with carefully orchestrated scenes requiring the presence of specialists with expert knowledge and tools. Moreover, given how the senses act as a vital bridge between smiths and the properties of metals, sensory archaeology has an important role to play in explaining technological change, by providing a framework through which the vertical and horizontal transmission of knowledge can be more deeply explored.[18] This issue is especially poignant for ancient smithing, as many techniques routinely employed within modern metallurgy to exert direct control over the properties of metals, such as refining, were only slowly developed after many centuries of engagement with metals. The effectiveness of modern metallurgy is dependent upon its capacity to incorporate standardisation into every stage of the process, creating a streamlined *chaîne opératoire* with consistently replicable outcomes even at scale. This level of standardisation was simply impossible to achieve before the invention of these modern techniques, and has contributed to a radical change in societal perceptions of metals. Past smiths were, therefore, even more reliant upon their senses to successfully produce metal artefacts, especially since they did not have access to the sensitive measurement and analytical equipment which is equipment essential to modern metalworking today.

[10] Various research institutions and organisations worldwide regularly encourage, facilitate, and publish the results of participation in experimental and experiential archaeometallurgy, including the Historical Metallurgical Society, EXARC, and the UCD Centre for Experimental Archaeology and Material Culture.

[11] As observed by Kuijpers (2015, 138), the terms 'discursive knowledge' and 'non-discursive knowledge' have acquired many additional implied meanings. This paper specifically uses these terms in relation to the transmission of knowledge.

[12] These two modes of communication should be seen as inherently complementary, and even, to a certain degree, symbiotic.

[13] See, for instance, the wide-ranging research on gold-based objects in the National Archaeological Museum at Athens produced in collaboration with Akis Goumas, e.g., Konstantinidi-Syvridi *et al.* 2014; 2019; 2020; 2024; Papadimitriou *et al.* 2016; 2021.

[14] Dolfini, Crellin 2016, 81.

[15] Coles 1962.

[16] Hermann *et al.* 2020: 18–19, 51–54.

[17] For example, Hoffman 1999.

[18] Although sensory and perceptual abilities are essentially pan-cultural (Hinde 1998, 176), smiths are trained not only to understand the implications of what they sense, but also to heighten their capability to perceive according to the criteria prioritised within their own metal-crafting tradition.

Despite the best intentions of individual researchers, developing a holistic and deep understanding of the properties of metals to produce meaningful archaeological research[19] is far from straightforward. Smiths gain this knowledge through repeated encounters with metal, an opportunity that few archaeometallurgists have the time or funding to embrace. Furthermore, the majority of experimental and, to a lesser extent, experiential archaeological projects aim to elucidate specific issues related to metal artefact production, rather than provide a general introduction to metal properties. The situation is even more difficult for archaeologists working chiefly outside archaeometallurgy who may, nevertheless, frequently consider metal artefacts in the context of cross-craft production or grave assemblages, as they could potentially have no or limited personal access or exposure to experimental and experiential archaeology.

Therefore, the aim of the first part of this paper is to attempt to impart some of the, especially non-discursively transmitted, knowledge vital to smithing, using a highly accessible form of experiential archaeology organised as a series of simple activities that involve basic household items. While the list of metal properties explored is not exhaustive and is mostly limited to those of greatest importance for metal-crafting in past societies, we hope that this guide will stimulate your curiosity to find out more.

The second part of this paper will delve more deeply into the way in which a smith thinks about the metal family and its properties, in particular by analysing why smiths choose to incorporate multiple metals into a single artefact through an intra-cross-craft perspective. Although the need for this approach within archaeometallurgy may initially appear counter-intuitive, it stems from the fact that each metal is best understood as a unique package of properties, due to the exact characteristics of its crystalline structure. Thus the knowledge, gestures, and equipment required to work with the different metals varies to the extent that the experience is akin to using completely different materials.[20] Since the combining of metals is one of the most powerful and common strategies through which a specific set of properties can be obtained, an intra-cross-craft approach is essential for understanding various aspects of decision-making by past craftspeople, including the ways in which metals can and cannot be used together. This will be discussed through several practical case studies that focus on the challenges and rewards of integrating multiple metals into a single artefact from an intra-cross-craft perspective.[21]

As this paper is based upon the experience of a single craftsperson, inevitably it is, to some extent, subjective. Therefore, we have purposefully focused here on general concepts with wide applicability that are, as far as possible, time agnostic. The individual properties of metals do not change over time, although continued human engagement has revealed more of them, as well as new techniques for controlling them. Nevertheless, some of the techniques discussed here, such as forging with a hammer,[22] will have been familiar to the early Neolithic pioneers of metallurgy, although the equipment and process have been refined and enhanced over the millennia.

Your guide during this journey is Dawn Hoffmann, a metal smith with over four decades of experience. Dawn works across an unusually wide range of metals: silver, gold, copper, brass, pewter, and bronze. She first studied with Fred Fenster and Eleanor Moty at the University of Wisconsin, Madison, during which time she also completed an independent study constructing a Mozart-era horn. This led to her being apprenticed to and working for a maker of French horns, Walter Lawson, for a number of years. She has continued to study and grow as a smith through intensive research, and hands-on learning through workshops and demonstrations given by blacksmithing guild meetings, conferences, and metal-smithing workshops run by various art/craft schools. Dawn feels that by producing beautiful utilitarian objects, mainly flatware (plates, *etc.*) and hollow-ware (jugs, bowls, *etc.*) as well as other household items, they have the presence to elevate the mundane: she aims to make practical, functional designs that speak with grace. One of her pieces, a sterling-silver punch bowl and ladle, forms part of the 1994 White House collection housed at the National Archives and/or Clinton Library. She is interested in replicating the practices in use from the Medieval and Early Modern Period through into the 18th century in North America and Europe, and how they were intertwined. Dawn is also a bookbinder, printmaker, and papermaker, and is working on a project to reproduce replicas of historical book furniture, as

[19] Kuijpers 2015, 138–139.

[20] Aulsebrook 2022, 100–101.

[21] This paper is not intended to provide a technical overview of metal artefact production. For further reading on this subject see, for example, Clarke 2013; Evely 1993; 2000; Fregni 2014; Untracht 1968. The number of citations within the remainder of this paper has also been kept to a minimum, to reflect the fact that the majority of the information discussed here has been accumulated by Dawn through her own personal engagement with metals and the world of metalworking, and contains a significant quantity of what is usually characterised as non-discursively transmitted knowledge.

well as to create original designs based on the ones held at the Folger Shakespeare Library,[23] and on books in the collections of the Library of Congress and the Dibner Library (part of the Smithsonian) both in Washington, DC. Metal fragments like these were also found in a well at Jamestown, in Virginia. As well as making metal artefacts, Dawn is a teaching artist and provides demonstrations, aimed at a wide range of audiences at various public events held at historical locations and arts venues, and public and non-public schools, to promote understanding of traditional craft techniques and their continuing relevance to the modern world.[24]

Part One: an Experiential Guide to the Properties of Metals

We welcome you to the first part of this paper, which provides an experiential exploration of the properties of metals. Treat this section as though you are present at a craft demonstration; it is not necessary for you to try all of these activities, but the more you can engage with, the more opportunities you will have to see, feel, and hear for yourself how metals function as materials. Please note, all the measurements used below are approximate, and there is no reason for you to bring along a ruler! As the purpose of this section is to shine light on the non-discursively transmitted knowledge necessary for metal artefact production in the archaeological past, it will concentrate on the properties that are most important for manufacturing metal objects, especially before the advent of modern machine techniques.

Malleability

Required items: a blunt pencil topped with an eraser, a spring-loaded ballpoint pen, a collection of coins (both silver and copper if possible), some chocolate wrapped in foil, thick aluminium foil, sellotape, scissors (or pen knife), something that can be used to make a soft surface (old newspaper, piece of felt, etc.), two stainless steel teaspoons, a piece of cardboard, and a piece of paper.

Let us begin by picking up the pencil and carefully looking at the metal ferrule that surrounds the eraser. Note the thinness of the metal and the dimples and lines incised in it that hold the eraser in place. Next dissemble the pen, and consider the spring that forms a fundamental part of the mechanism: its shape and again, the thinness of the metal. Do the same with the coins; take a moment to think about their design, if you can feel the shape of the motif with your fingers or perhaps any ridges around their exteriors. It is astonishing that one type of material can take all these different forms, and yet we take this for granted. Malleability, the willingness of metal to be formed into new shapes, is perhaps the most exciting, and certainly one of the most useful, properties of the metal family tree. The extreme malleability of certain metals, like gold and aluminium, make it possible to stretch them out very thinly into foils, to one-tenth of a micrometer (0.1 µm) in the case of gold. This requires hammering, or more recently rolling, the metal many many times. Unwrap the chocolate and note the thinness of the foil wrapper, and how responsive it is to pressure, making it easy to transform it into new forms to suit any chocolate shapes without tearing.[25]

The ability to shape metal in this way has been exploited not only to create different shapes but also to decorate artefacts. Embossing is one popular method, where the metal is worked from both the front (chasing) and the back (repoussé) to create relief decoration (Fig. 1). To have a go at embossing yourself, you will need a 5 x 5 cm square of aluminium foil, a soft surface, a pen (retracted) and a blunt pencil. First, lay your foil on top of the soft surface, and experiment with using the pen and pencil (both ends) as tools to press the foil down into the soft surface. Try applying different pressures. Then, starting from the centre, use one of your tools to create a depressed circle, at least 2 cm in diameter. Aim to press gently, but consistently, and repeat multiple times to create depth without ripping the foil. Now turn the foil over. You should have a protruding circle. You can better define its edge by running your tool around its perimeter, pushing the metal back the other way. You can also add extra details, like line-and-dot filler decoration, by pushing the metal from the front.

The ability of metals to be formed into wire (Fig. 2), that is their willingness to be transformed through tensile stress (being pulled) rather than compressive stress (being squashed), is often referred to as ductility. Making the pen spring required a metal that is both ductile (to make the wire) and malleable (to form the wire into a spring).

Not all metals are so malleable; to change the form of iron or steels, for instance, the metal must be heated. The glow emitted by the metal indicates its temperature. Steel must be heated until it is yellow-orange (roughly

[22] Martin 2023, 20–24.

[23] The online catalogue of their book bindings and furniture can be found here: https://luna.folger.edu/luna/servlet/BINDINGS~1~1 (accessed 21/10/2024).

[24] More examples of Dawn's work in various media can be found at: https://dawnartdesign.com/ (accessed 21/10/2024).

[25] This property is the foundation of gilding, which in prehistory means the covering of artefacts with hammered metal foil, as

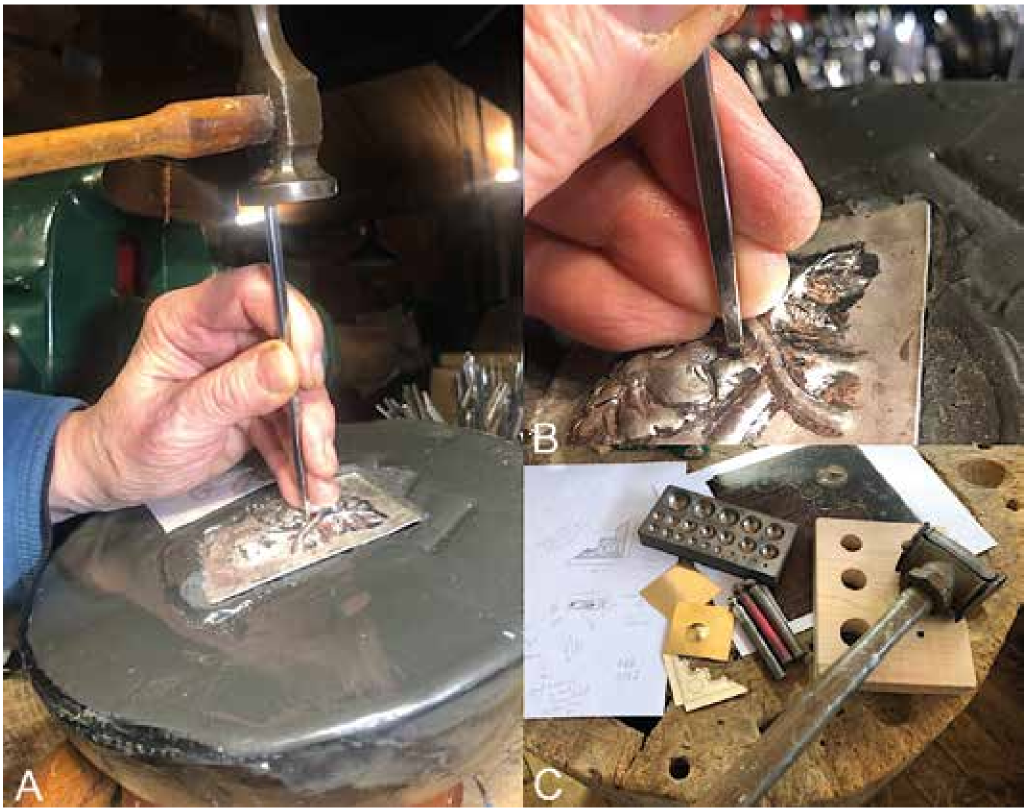

Fig. 1. A, B – adding chasing to a repoussé design, with pitch bowl supporting the work, using a hardened steel tool and metal surface; C – wooden and steel dapping blocks with punches, the resulting pieces are shown on the left-hand-side of the photo (photo by Kent Heimer/Dawn Hoffmann).

Fig. 2. A – drawing wire through a drawplate; B – various sizes of supporting T-stakes, mushroom stakes, wooden, steel and urethane forming blocks; C – a selection of various sizes and weights of hammers (all based on the traditional forging hammer with a cross peen and a round-faced hammer face); D – anvil for cold forging non-ferrous metals, samples show pattern and stages of making a spoon (photo by Kent Heimer/Dawn Hoffmann).

Fig. 3. A – hot forging iron at yellow-orange heat; B – iron in the coal fire and on the anvil before forging; C – cold forging silver using the cross peen face of the same type and weight of forging hammer to spread the metal (note the shinier anvil); D – two stages of raising a copper sheet over a T-stake using a cross peen raising hammer (photo by Kent Heimer/Dawn Hoffmann).

1100–1250 °C) before it is possible to hammer it into shape (Fig. 3). Hotter temperatures (white-yellow or even white-hot) increase its malleability, and pass into the range required for welding (see below).

Forging is the general term used to describe changing the length, width, or thickness of the metal being worked, which is usually received by the smith in the form of a standardised shape (bars, rings, *etc*.).[26] Sinking is when the metal sheet is stretched downwards into a new shape, whereas raising (Fig. 3) uses compression stress to change the direction of the angle of the metal (from a flat sheet into a bowl form, for example). Using these techniques, the scale and type of work can range from making a tiny rivet to raising a bowl or teapot, or from forging a gate to making its hinge.

You can have a quick experiment with forging, using some aluminium foil, two spoons and a piece of cardboard. Cut out a 5 x 5 cm piece of foil; if you want to be able to compare the before and after effects, carefully trace around it on a piece of paper. One of your spoons will be the anvil, laid on the cardboard with the back uppermost (you might want to tape it in place), the other is your 'hammer', which you will use with the back facing downwards, so that the foil will be squashed between the two convex surfaces. Starting about 1 cm away from the point and working towards it, hammer the metal so that you stretch it towards the point. It will be noisy! Try to take care not to rip the foil. Of course, with such a thin piece of metal the results will not be radical, but if, after trying this at all four corners you then compare the foil to your original drawing, you should be able to see a slight bulge at each of them.

You can try out sinking as well, using some cardboard, a spoon and some aluminium foil. Cut out a 5 x 5 cm piece of cardboard and cut a 2 x 2 cm hole in the centre. Make two more of these, stack them so that the holes align and tape them together. Cut a 5 x 5 cm piece of aluminium foil and place on top, then securely tape it down around the edges. Start pressing the foil down into the central hole with the back of the spoon, using steady pressure to slowly stretch the metal downwards into the hole. You should end up with a slight bowl shape. This technique is often used to begin the manufacture of a hammered bowl or other hollow-ware products.

As you have experienced, when forming metals in this way, there always needs to be some kind of support underneath the material in order to prevent it from collapsing, and to squash it in-between the hammer and the supporting tool. Anvils take many forms, from the well-known blacksmith-type anvil to a silversmith's T-stake or mushroom stake, or a tinsmith's bick-iron or edge-tool roller (Fig. 2). Depending on the metal being worked, the thickness and hardness of the metal, and the amount of movement required by the craftsperson, the supporting tools can be made of many materials, steel tools being the most common nowadays (hardened and non-hardened steel), but also wooden hollowed-out forms, hard plastics, chaser's pitch (pine rosin, tar, plaster, or brick dust and oil-based supporting material), antler or bone, and various clays (Fig. 1). Hammers, too, take many forms, usually based upon two typical faces: one

opposed to the much thinner gold leaf employed today, as attested at the Chalcolithic Varna cemetery (Renfrew 1986, 149).

[26] See, for example, the wide range of semi-products (raw iron ingot forms) known from prehistoric Europe, the shapes of which were used to indicate the quality of the metal (Berranger,

a variant of the rounded flat face, and the other a rectangular face, known as a cross peen (Fig. 2). The shape, size, degree of roundness, edge profile, and weight greatly vary the impact the hammer has on the metal, and how the metal compresses and moves beneath the repeated blows.

Strength, Hardness, and Brittleness

Required items: a blunt pencil topped with an eraser, thick aluminium foil, two stainless steel teaspoons, a pen knife, a piece of paper, a metal paper clip, and a collection of coins (both silver and copper if possible).

Two other exceptionally important properties of the metal family tree are high tensile strength and hardness. The majority of metals are much stronger and harder than many other common materials; they better resist forces that could pull them apart and are less likely to deform upon impact. This provides them with the toughness and durability needed to use them for so many different purposes, from tool heads to suspension bridges. You can test the strength of metals by using one end of the paper clip to poke holes in the paper; even though the wire of the paper clip is very thin, it can perforate the paper without bending.

However, increased hardness comes with a cost because harder metals are generally more brittle. This is one of the most influential reasons as to why different metals are suitable for different tasks. Test out the relative hardness of the collection of metal objects you have gathered by using them to scratch each other. Which metals were more readily marked? These are softer metals. Your steel penknife should be able to mark all the other objects, whilst remaining unmarked itself. The decorative technique of engraving relies on these differences in hardness (Fig. 4).

Resistance to abrasion is important for many applications in which metals are involved, such as tools for filing or ball bearings used to ensure the continued smooth operation of a mechanism. Nevertheless, the ability to abrade softer metals has been exploited for various purposes, one of which you can try for yourself. First, rub the edge of a silver coin over a sheet of paper and observe if there are any markings (most likely there will not be due to the smoothness of the paper). Now, rub the pencil eraser on the piece of paper, leaving the eraser crumbs in place. Try rubbing the silver coin edge over these crumbs onto the paper. You should be able to leave a mark on the paper more easily this way. Before the invention of the graphite pencil, thin lead, copper, tin, and silver rods, so called 'metalpoint' styli, were used for drawing. The paper or substrate had to be treated beforehand to create a rough surface which abraded the metal to leave a trail. This treatment was a painted-on ground containing a mineral grit. The grit in the eraser created a little bit of roughage that was enough to abrade the edge of the coin in a similar way to the painted-on ground used for metalpoint substrates.[27]

Now take the paper clip, open up its first joint and keep bending that small sliver of wire back and forth until it breaks. If you look closely at the end of the paper clip, you will see the crystalline structure of the metal at this break point. What happened? Why does the paper clip initially bend, but eventually snap? You have just witnessed 'work hardening' in practice. The crystalline structure of the metal has been stretched and compressed beyond its cohesive capability. The individual metal grains are no longer able to slip past each other with the same ease, due to faults accumulating in the structure. Work hardening always takes place when the crystalline structure is distorted; for example when we change the shape of a piece of metal through hammering, rolling, or die-forming. Due to the trade-off between hardness and strength discussed above, the loss of malleability through repeated bending of the paper clip causes it to become increasingly brittle until it snaps. You can test the increase in hardness by scratching your coins once again with the now work-hardened paper clip, to see if this increases the ease and extent to which you can mark the coins.

Work hardening can be beneficial and is often incorporated into the *chaîne opératoire* of certain objects deliberately. Toughening tool edges, whether on a knife blade or a snowplough, is one example;[28] another is using stamping to produce a coin or spoon, so that it does not bend readily and keeps its shape. If you pick up the pen knife and whittle the lead end of the pencil, you are taking advantage of a work-hardened tool edge. Try to bend the largest coin in your collection with your bare hands; what you are experiencing now is the power of work hardening and the associated loss of malleability. For iron and steel, hardness can also be increased through a special process of heating and rapid cooling (quenching), with a further cycle of heating (tempering) used to scale back the associated gain in brittleness without compromising the additional hardness. Like work hardening, this can be selectively applied.

Fluzin 2012). As mentioned above, forging metal to change its shape is one of the earliest known techniques.

[27] Although it has been suggested that the reason why modern pencil cores are still known as 'leads' is because the first graphite deposits were mistaken for lead metal, it is also plausible that this name came about because the pencil directly replaced the most widely used form of metalpoint styli, which were made of lead.

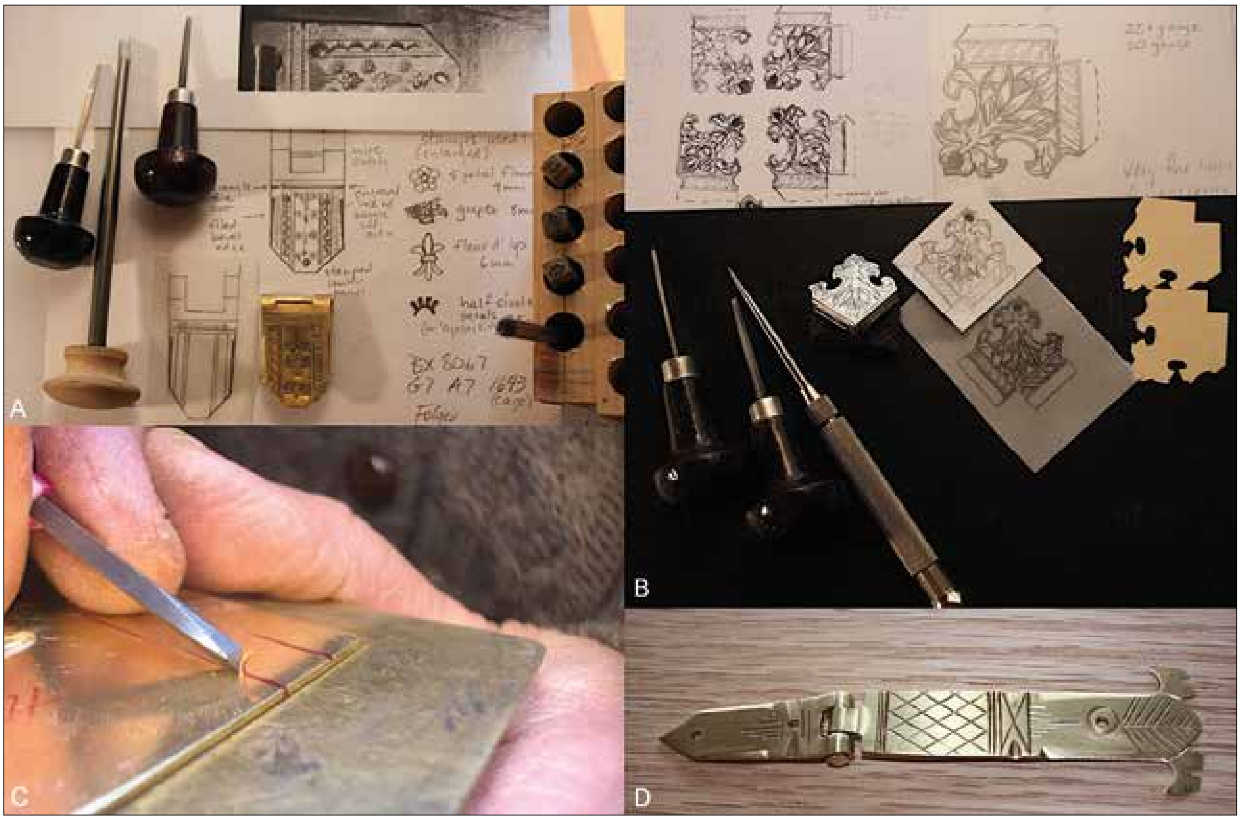

Fig. 4. A, B – patterns and tools used to scribe and engrave book furniture, with examples of formed and engraved work; C – close-up of engraving a line; D – common design of traditional book furniture forged at widest part, filed and engraved, hinge section formed and bent, stem riveted at both ends to prevent dislodgement in use (photo by Kent Heimer/Dawn Hoffmann).

Sometimes, though, work-hardening can be undesirable. The increasing brittleness of the metal can threaten the successful production of an object. However, malleability can be restored through a process known as 'annealing'. Annealing involves heating up a metal object to a temperature that enables the crystalline structure to reset within the new shape.[29]

Certain metals, like lead, tin, and related alloys (pewter, Britannia metal), never work harden at room temperature. Their melting points are close enough to room temperature so that distortions to their crystalline structure can be healed without a smith needing to initiate a cycle of annealing. Furthermore, these metals soften, *i.e.* become more malleable, by being worked. This is because of the way in which their crystal faces are formed, with easily displaced bonds enabling increased slippage between individual crystals (strain softening). These metals, therefore, are easy to work yet stay soft, and will continue deforming during use or further working.

Finally, the deformation/shaping of metals also helps increase their resistance to bending. This is evident on the thin ferrule that attaches the eraser onto the pencil; most likely there are ribbed grooves or another form of texture, as well as indentations. This textured surface is not just for decoration, as the changes in the direction of the thin metal sheet strengthens its resistance to bending (in limited ways) and helps it to hold the elements of the pencil in place.

Lustre and Smoothness

Required items: thick aluminium foil.

Pick up some of the aluminium foil and admire the way in which it reflects light. Shine, or lustre, is one of the most obvious visual properties of the metal family tree. All metals can be brought to a shiny polish; however, the method for doing this varies. Iron requires grittier, harder sanding or scrubbing to achieve a smooth finish

[28] As seen on archaeological examples through metallographic analyses; see, *e.g.*, Mödlinger, Trebsche 2021.

[29] Annealing leaves characteristic traces in the microstructure (annealing twins), which have also been observed in archaeological artefacts; see, *e.g.*, Mödlinger, Trebsche 2021.

and tougher polishing compounds because of its hardness, whereas softer metals often need very little scrubbing and require a soft polish compound. In the past, gold and silver would be finished by rubbing a soft pumice stone to smooth the surface and then were burnished with a polished hard stone (*e.g.*, agate or haematite) to achieve a shiny surface. Today they are more likely to be treated with sandpaper of coarser to finer grits, followed by a series of coarser to finer polishing compounds (using a buffing wheel) to achieve a shiny finish. Whilst certainly aesthetically pleasing, lustre has other uses and benefits as well. Mirrors are an obvious example.[30]

If you run your fingertips lightly over the aluminium foil, you can appreciate how smooth metals can be. This smoothness again can have uses and benefits beyond visual beauty; mechanisms, for example, rely upon having components with smooth surfaces, and damage to this smoothness can cause them to fail.

Reactivity: Oxidation and Patinas

Required items: a collection of coins (both silver and copper if possible), a plastic beaker or old mug, and a weak acid (such as a fizzy soft drink, like lemonade or cola, vinegar, or lemon juice) mixed with a little table salt.

Take a look at your collection of coins. Do specimens of the same denomination all look the same? Perhaps their colour is slightly different or some of them are more dull. What you are observing are the effects of oxidation and corrosion, caused by reactions between the metal and its environment, including air, water, soil, and various chemicals. Initially, this can cause discolouration of the surface and pitting, which compromises lustre and smoothness. However, some degree of reflectivity, on metals like copper and silver, is retained if the metal remains smooth enough. An example of this is the bronze roof on Dawn's workshop, which still brightly reflects the sun even though it is now brown from acid rain that has made a skin of corrosion, known as a patina, on the polished surfaces. Patinas can be produced intentionally, using chemicals to speed up the reaction, and these can be used decoratively to create interesting contrasts between shiny and dull surfaces or in colour.[31]

Over time, corrosion products can build up on the surface. These do not share the same properties as their parent metal. One of the most extreme examples is iron, which transforms from a greyish hard metal into rust, a reddish brittle substance. Indeed, as mentioned above, one reason why gold has been so valued over millennia is because of its inertness, meaning that it does not tarnish. Annealing also causes these reactions to speed up, because of the application of heat, but luckily there is a way to remove corrosion products from the surface and continue making an artefact: pickling.

You can test pickling yourself with an oxidised (dirty-looking) coin and weak acid of your choice (*i.e.*, a fizzy soft drink like coke or lemonade, lemon juice, or vinegar) mixed with a little table salt. Drop the coin and your acid into the plastic beaker/old mug, and leave for a few minutes before checking to see what has happened.

As well as being an essential part of annealing metals, pickling is also the concept that lies behind the etching of metals; acid is selectively applied to remove a small proportion of the surface, creating a decorative pattern or even a plate of text.

Heat: Conductivity and Resistance

Required items: a metal paper clip, a lighter or candle+matches and thick aluminium foil.

Metals are superb conductors of heat, making them the material of choice for thermal exchange, such as radiators and cookware. You can test the former yourself if you unfold the rest of the paper clip and carefully hold it in the flame of the lighter for a few moments. You can also do the same with a small piece of aluminium foil (*e.g.*, 5 cm x 2 cm) and a candle; very quickly you will see the metal visibly sag. Use pliers if you are worried about burning your fingers! Do not leave the metal in the flame too long, otherwise it will start to melt. If you do want to experience melting, it is better to use a thin strip of aluminium, and ensure you use pliers to hold the other end. You will see the metal sag, curl up into a ball and then drip.

The melting point, the temperature at which a solid will become a liquid, varies between every metal. The melting point of mercury is so low that it is liquid at room temperature. However, a number of metals have exceedingly high melting points, including gold (1064 °C), iron (1538 °C) and tungsten (3422 °C). This in itself can be a useful property; if you have a lighter, you can observe that the areas closest to the flame are made of metal, especially chosen to resist damage from such proximity to the heat source.

Conversely, the ability to melt metals can also be a beneficial property. Molten metal can be cast into shape

[30] For recent research into the production of mirrors, see Thomas 2024. For a case study of the societal impact of the introduction of metal mirrors on past societies, see Alvarez 2023.

[31] See, for instance, the range of artificial patinas applied to Ancient Egyptian artefacts (Mohamed, Darweesh 2012).

using a mould, providing an alternative method through which metal artefacts can be made.[32] Broken and obsolete metal objects can be melted down and the material reused again.[33]

Sonority

Required items: stainless steel teaspoon, an empty can, a collection of coins (both silver and copper if possible).

Drop one of the spoons on a hard surface or a few of the coins together, and listen. Metals are sonorous: they make a sound when struck or otherwise vibrated. Now try tapping the empty can with the spoon. It should be possible to make a ringing noise. The quality of the sound varies according to the type of metal, its form, and the way in which it has been worked; metals clink, jingle, rattle, chime, crash, clank, tinkle, *etc*. Although obviously of great use for the manufacture of bells and musical instruments, this property is also significant to craftspeople. As you have experienced when trying out forging, the process of hammering metal is noisy. As the metal work hardens, the note produced by repeated blows to the metal changes. A smith can thus use the sound the metal is producing to gauge the degree of work hardening, and therefore when it is necessary for the metal to undergo a round of annealing to re-soften it. This occurs before any visible changes to the metal, like cracking, thereby enabling smiths to avoid damaging the objects they are making.

Integrating Properties

So far, this guide has focused upon the individual properties of metal that are of the greatest significance to craftspeople. Of course, this is by no means a comprehensive list, but there is no space here to enumerate every single one. Weight, for instance, influences the selection of aluminium to make airframes and lead to make fishing-net sinkers. The density of lead makes it an excellent choice for radioactive shielding. The main three magnetic metals, iron, cobalt, and nickel, are used for many purposes, from fridge decoration to MRI (magnetic resonance imaging) scanners. Metals are also good conductors of electricity and thus form the core of the electricity grid, from domestic copper wiring to power station transformers. Every time you switch on a light or charge your phone, you are taking advantage of the electrical conductivity of metals. There are hundreds of further examples that could be listed here.

Rarely is a particular metal chosen for a specific task based on one property alone; it is the combination of properties unique to each metal that drives the selection process. The metal used for the paper clip must, for example, be ductile enough to be drawn into a thin wire, and malleable enough to be formed into the shape of a clip, but strong enough to resist snapping even with repeated use, and hard enough to prevent deformation if dropped on the floor.

The range of applications for metals can, therefore, be significantly widened if two or more metals are used together. In this way, different properties can be integrated to create objects with characteristics that could not be replicated using a single metal. This is also the case for non-metal materials. Make a thorough examination of the pair of glasses or the ballpoint pen. Look at the role that each metal piece has and how these components are joined together to make the whole. To function properly, both of these objects have to be made of multiple types of metals and incorporate other materials. Hammers, with their wooden handles for comfort and hard steel heads, spoons, with their steel bodies for strength and heat-proof handles, a finger ring with a stone set into it, or a computer integrating metals, plastics, and silicates, are all examples of using multiple materials to mix and match desired properties. Pick up and consider again your pencil, with its graphite lead encased in a wooden barrel and its eraser ferrule made of metal. These are just a few daily examples that readily come to mind.

When those other materials are perishable, archaeologists can be confronted by metal artefacts that at first glance have no discernible use. Book furniture pieces are an excellent example of this problem; individual pieces have holes punched into them or are equipped with hinges, but they cannot function as a sieve or spoon, and are too small and lightweight to be a box or door hinge. Options only open up for exploration when you think about how these pieces might be used in conjunction with other media. The production of metal-based artefacts can, therefore, simultaneously be inter-cross-craft and intra-cross-craft.

There are two main ways in which metals can be combined with other metals. The first, joining, mimics the way in which metals interact with non-metal materials. The second, alloying, is specific to the metal family tree.

[32] See Radivojević *et al*. 2021 for a discussion of the earliest known applications of casting.

[33] Contexts such as the Unexplored Mansion at Knossos, where broken artefacts were found in the vicinity of a hearth, provide archaeological evidence for metal recycling in past societies (Catling, Jones 1977, 57).

Fig. 5. A – Kent Heimer welding with an arc welder; B – brazing a piece of brass (note flame size); C – welding a piece of pewter with (a relatively cooler) tiny flame (photo by Kent Heimer/Dawn Hoffmann).

Joining

Required items: a blunt pencil topped with an eraser, a spring-loaded ballpoint pen, a pair of glasses, thick aluminium foil, scissors.

There are a variety of ways in which metals can be joined to each other and to non-metals: screws, nails, joints, welds, rivets, sockets, solders, *etc*. Your pencil ferrule, made of thin crimped sheet, is an example of how metal can be used to create a join between two non-metals. Some of these techniques, like nails, can be used for a wide variety of materials. Others, like soldering, can only be used to join metals to other metals. You will notice that some of these joining techniques, like nails, screws, and rivets, require an additional metal-based component.

The hot joining techniques, welding, brazing, and soldering (Fig. 5), take advantage of the property of metals to melt in order to create the join. These three terms refer to the temperature used during the joining process and, due to their varying melting points, this means different types of metals and alloys are used for the added joining materials. Welding makes the strongest bonds. When welding, the temperature used is hot enough to melt the welding rod and the pieces to be joined. This, of course, varies metal by metal. For pewter, the temperature for welding only needs to be 246 °C, but for steel, it needs to be much higher: 1760 °C. The welding rod is made out of the same material as the parent pieces. Whilst the temperature used for welding is situational, the temperature difference between brazing and soldering has a fixed definition. Brazing takes place at a temperature above 600 °C. The join cannot have any air gaps. The joining material (brazing compound) is an alloy that has some similarities to the parent pieces, but also contains metals that lower its melting point below that of the parent pieces. Therefore, only the brazing compound is melted. Soldering takes place at a temperature below 600 °C. Solder is primarily composed of metals with a low melting point, like lead or tin, and can be very different in composition to the parent pieces if used to join metals with a much higher melting point, like copper or silver. Solder, though, has the advantage that it can be used to patch gaps. Brazing and soldering are less risky techniques, because the danger of damaging the already-worked pieces whilst joining is much lower, but the joins they make are not as strong as welding.

You can have a go at making a rudimentary join yourself using two 5 x 5 cm pieces of aluminium foil. Make an 'L' shape along one edge on each of your pieces; the short leg should be quite shallow, between 0.25 cm and 0.5 cm. Hook the two short edges together with one facing upwards and the other downwards. Pressing sideways on the top piece will push both hooked folds together. This basic seam type is often used in tin smithing.

Alloying

Required items: stainless steel teaspoon, a collection of coins (both silver and copper if possible).

Another rather distinctive and important property of metals is their ability to be alloyed; elemental metals, like silver, copper, or iron, can be mixed with other metals or even, in the case of iron for example, other elements (in this case carbon to make steel) to form a new metal. In most cases, this new mixed metal will combine properties of its parent metals, sometimes simply augmenting or diminishing them, sometimes adding or removing desirable or undesirable properties.[34]

Take a look again at your collection of coins. The range of colours on display is well beyond the natural palette provided by pure metals. Alloys, as well as certain surface treatments, are used to create new colours, as well as to mimic more precious metals, like silver, through alloys of copper and nickel, for instance. Gold-coloured coinage includes brass (copper and zinc alloy) or bronze (copper alloyed with tin).

Now turn your attention to the stainless steel teaspoon. To function well, a teaspoon must stay corrosion-free despite being exposed to difficult environments, like being plunged into boiling water. Steel, itself an alloy of iron and carbon, is made more resistant to corrosion through the addition of zinc, chromium, nickel, and molybdenum. Hardening metals and making them less vulnerable to corrosion are two of the main reasons for using alloys. A finger ring of pure silver would be worn out much sooner than a similar cousin made with sterling silver; alloying the silver with copper to create sterling silver adds durability. Sterling silver, however, the same as pure silver, will still tarnish, and it is now being surpassed by the newest mainstream silver alloy, argentium: a modern tarnish-resistant silver alloy, which stays bright due to the addition of germanium. Gold also is alloyed to add hardness and durability. Copper is often alloyed with tin or zinc to make bronzes or brasses that can take wear and resist weathering to a greater extent than pure copper.

However, this does not mean that alloys are 'better than' pure metals. It is important to pick the correct metal for a specific task. Brasses can fatigue faster in some working conditions and do not necessarily transmit electrical impulses as well as pure copper. Pure gold, which would be too soft for most jewellery, can be used to make leaf and coatings that are more resistant to corrosion. A high-carbon steel may be too brittle and hard for certain tool usages that would be better served by a softer mild steel. There is a place for all of these variations.

Just as individual pure metals can be joined together to take advantage of their unique characteristics, so the same can happen for alloys. When making a modern axe-head, a soft mild steel may be used to form the outer part of the sandwich around an alloyed high-carbon steel. The high-carbon steel, the harder and more durable material, only needs to be exposed on the very edge of the axe-head to make the axe function well. Alone, the mild steel would not hold up to the cutting and splitting of wood. With the harder high-carbon steel sitting in-between the mild steel sides, it does a fine job of providing density and weight to the tool head. Alloying, therefore, acts as a method through which a particular package of properties can be fine-tuned for a certain purpose.

Summary

This marks the end of the experiential guide to the properties of metals. We hope that this brief set of basic activities has provided a useful glimpse of the vast landscape of both the discursively and non-discursively transmitted knowledge that surrounds smithing, which plays such an important role in learning to predict the behaviour of different metals during production. We have stressed how smithing, particularly in past societies, should be viewed as a multi-sensory engagement with each individual piece. This need to build a relationship in order to achieve a successful outcome may help explain why tradition and cult practice are just as relevant to the overall human-metal story as technical innovation and experimentation.[35]

It is time now to consider, from an intra-cross-craft perspective, how the different packages of properties represented by each type of metal relate to each other, and the impact this has on metal artefact production through actual case studies.

[34] It is possible that this practice of deliberately alloying two metals together (rather than using an alloy found in nature) dates back as far as *c.* 4650 BC (Radivojević *et al.* 2021, 21).

[35] Budd, Taylor 1995.

Part Two: Working with Multiple Metals

As has been discussed already, within the family of metalworking disciplines there are many similarities and overlaps. However, at the same time there are also enough differences between the metals, in terms of their properties, to warrant their own fabrication practices undertaken within individualised workshop settings. After the more general discussion of metal properties in the previous section of this paper, it is now time to consider how an understanding of these various characteristics can inform us of which materials, processes, and tools would be best-suited for the job at hand. Therefore, this section is built around following the thought and decision-making processes that underlay the manufacture of nine objects that Dawn has produced. These specific case studies, which cover both ferrous (iron-bearing) and non-ferrous metals, will demonstrate some of the parallel and contrasting working conditions required. The case studies comprise both replicas and private commissions.

As mentioned above, Dawn has an interest in the history of her craft, and often draws inspiration from the material culture of past societies. She produces all her pieces by hand, although making use of modern tools and facilities (bottled fuel torches, motorised buffing tools, *etc*.). Such technology brings many benefits, in particular decreasing the time and physical effort required, while increasing the degree of control over many critical procedures, like the application of heat. However, fundamentally the underlying processes (forging, soldering, *etc*.) are the same, even if the technique itself may have changed. Moreover, the properties of the metals themselves remain unaltered; our improved understanding of metals and technological progress may enable Dawn to reproduce certain archaeological artefacts in a different way, but her work is ultimately rooted in a millennia-old craft, and offers archaeologists another experiential source through which a fuller appreciation of the complexities of metals can be grasped.

As an artist as well as a smith, even though Dawn concentrates on the production of utilitarian artefacts, she has a greater degree of flexibility in terms of the design process that may not be applicable to the majority of past craftspeople. The possible exception to this is the category of specialists identified by Kuijpers as 'virtuosos' who, although rare, had an outsized impact on their craft, by exploring the limits of materials, creating original objects, often laden with ideological and political meaning, and using unconventional techniques.[36] Therefore, a general overview of her decision-making during the design process will still shine light on an aspect of metalworking of relevance to the study of past production, as well as providing insights into the range of additional constraints on smiths beyond those imposed by outside circumstances.

Decision-Making during the Design Process

When Dawn sets out to make a piece, her first thought is about its utility. Does it need to support weight in some way, or will it be under compression? It is crucial that the metals can physically do what is required of them in order for the object to function well. Already, based upon Dawn's extensive experience, the answers to these questions can start narrowing down the types of metals that can be used. Other things that she gives immediate consideration to is who will use it, and how and where will they use it. Scale is another important factor: what size does the piece need to be in order to perform well? Metals often have limits of performance depending on their thinness or thickness, which must be taken into account. She also thinks about the qualities she wants the piece to express: gracefulness, lightness, strength, sturdiness, openness, solidity, or a combination of these, or any of the many other possibilities. These considerations alone may be enough for her to whittle down the possible candidate metals, in terms of exact alloy mixes, to just a handful, identify how many different materials would be required, and how they would interact with each other. Even at this early stage, it is already important for Dawn to think about the finish, as each metal has its own distinctive type that presents advantages but also vulnerabilities. Will the piece be used predominantly indoors or outdoors (or both)? Its intended environment can impact the rate of oxidation and corrosion, as can many other factors that must be taken into account. Does the piece need to be food-safe? Will it be subject to much wear? Does the surface need to be decorated, or will the design be inherently visually satisfying or arresting enough that the form alone will carry the work? For the latter, perhaps counter-intuitively, simple shapes are often the hardest to execute well, as ensuring the correct flow of a line by hand can be challenging. Again, these factors can considerably narrow the range of favourable choices, and have a bearing on which materials are required and how they will interact with each other.

For Dawn, the process of translating the qualities she seeks into practical manufacturing choices requires inspiration, which she personally experiences as a lifting up of spirit: this process varies in tempo, sometimes requiring years of patient observation, and to her is analogous to

[36] Kuijpers 2018, 563.

watching the unfolding of a flower, petal by petal, as each element falls into place. Boundaries are not just set by the properties of the metals, but also restrictions on time, cost, tools, and the cultural expectations of clients, amongst many other factors.

Sometimes, Dawn has found that the design and methodology come together before working directly on the metal. Therefore, she has a full mental template of the likely process before she starts. In other situations, the work in progress seems to point out alternate ways to solve a problem of manufacture and the design is improved upon while the object is being made. Thus, the *chaîne opératoire* shifts during the process of manufacture. In certain cases, it is simply not clear whether a specific task is required until that moment is reached. For instance, if a piece has become really super work-hardened then it could begin cracking if left in a highly stressed state. This is particularly likely for brasses. The piece would need to be annealed, and perhaps gently worked over again in order to strike the right balance between hardness and stress to avoid deformation during use. Often, only after the piece is considered complete will it become apparent whether it requires additional work like this. Therefore, to achieve the best outcome, the exact *chaîne opératoire* used emerges through the relationship between the smith and the individual piece.[37]

Some metals can only withstand a certain quantity of working before they fail, so even the complexity of the design has a direct bearing on the choice of metals. Nowadays, there are a very wide range of alloys, each with a very well-understood specification of properties, from which smiths can select the most suitable type. As one moves further back in time, the range of different metals available decreases. We see past smiths creatively experimenting with metals, pushing to see what they were capable of and exploring new possibilities.[38] We also see them having to compromise, and work within the limitations of what was available to them at the time.

Choosing a Chaîne Opératoire

Fundamentally, each metal has its own specific repertoire of techniques. Although the underlying concept may be the same, with shared facilities, tools, and methods, details of the execution vary. Annealing is a good case. Both copper alloys and steel work harden, and thus require annealing. For copper alloys, this involves a separate process that has been described in detail above. For steel, annealing occurs when it is placed in the fire in preparation for the next round of hot-working, and pickling and/or quenching do not occur until the piece is finished.

Each metal has its own variant of how volume can be achieved. Many metals are now regularly spun on a lathe with varying degrees of depth, after first being annealed. The earliest known evidence for this technology is a Ptolemaic rock relief (c. 300 BC).[39] Silversmithing often works the entire continuous surface of the metal, changing its direction to form the desired shape. The same style of working is often employed for copper alloys. In contrast, forging bar stock to change its thickness, length, and direction, with multiple pieces added in, is the common production sequence applied to iron. Tin-smithing techniques create the volume and shape required by concentrating on the formation of edges and joints on pattern parts that are then fixed together to create the whole. Similarly, construction techniques use multiple pattern pieces, but a wider variety of joining methods: welding, riveting, folding, and soldering. The assembly sequence can be affected by which metals are involved when using heat for these joins. Those joins that use harder solders and brazing compounds need the most heat and must be worked first, otherwise already-completed joins that involve a solder or compound with a lower melting point may end up coming apart.

These unfinished brass dividers (Fig. 6), which have mortise-and-tenon riveted leg ends made of Damascus steel, combine blacksmithing and whitesmithing. Although the former term is familiar, and refers to the use of fire, 'whitesmithing' denotes a manufacturing process without fire, and relies upon using a file to provide the final shape to the metal. This, though, still entails a great deal of work: filing, checking the fit, filing again, checking from every angle; slow careful work until the smith is eventually satisfied with the result. Both the brass and the steel were whitesmithed in order to fit the two parts together. The process for making the Damascus steel could hardly be more different. It is made of multiple layers of a nickel-steel alloy and carbon steel, twisted to form the patterning. To achieve this, the layers were repeatedly cut and forge welded back together (at 1760 °C), and then forged back into a bar shape after twisting. Forge welding is all about heat and pressure, and the only added material is a flux to prevent oxidation and keep the joins clean. Steel was chosen for durability. It appears regularly in classic drafting/writing sets because of its hardness

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[37] The rigid adherence by past craftspeople to a specific *chaîne opératoire*, despite substandard outcomes in terms of quality, may indicate limited knowledge of the range of available techniques or the prioritisation of another factor, *e.g.* time, standardisation, or tradition.

[38] Kuijpers 2018, 563.

[39] DeVries *et al*. 1980, 52.

Fig. 6. Pair of brass and Damascus steel dividers in progress, during whitesmithing stage. (photo by Kent Heimer).

Fig. 7. A – pewter pitcher with riveted walnut handle; B – in-progress embossed silver box inlaid with gold, with wired lid awaiting brazing, embossed decorative top, required tools (hammer, chisel, agate burnisher) on right, and sample of gold onlay on left; C – folding knife with blade of Damascus steel and decorated sheath of iron and bronze (photo by Kent Heimer).

and ability to keep a point. The two metals were joined together by riveting, because the temperatures that each need to reach for hot joining (welding, brazing, *etc.*) are too disparate.

This folding knife (Fig. 7) showcases the combination of steel and copper alloy in another way. The Damascus steel blade, formed of nickel and high-carbon steels, is housed in a patterned iron sheath. This sheath has then been overlaid with molten bronze for both colour contrast and texture.

Working with pewter is a very different experience to working with other metals. Unlike other members of the metals' family tree, pewter softens through being worked. Efficiency is therefore key. All hammering and direct shaping has to be kept to a minimum, so that the metal remains hard enough not to deform during use. This pitcher (Fig. 7) was made by what is known as the construction method. Flat sections were shaped and then welded together, and afterwards finished with light planishing. Low-temperature solder is very visible against the natural colour of pewter, so welding is used to avoid unsightly miscoloured seams. Casting is another good method for shaping pewter without overworking it. Pewter was originally a tin-lead alloy, and was not food-safe, despite being extensively used for dining and drinking equipment. There are now a number of modern lead-free pewter alloys, which have allowed the tradition of pewter tableware to be extended while adhering to current safety expectations. Their working properties are very similar to the original tin-lead pewter. This pitcher was made from a specific lead-free pewter alloy known as Britannia metal (92% tin, 6% antimony, 2% copper). The walnut handle is attached by a copper rivet, as a pewter rivet would not be durable enough.

Sometimes, it is possible to achieve a particular goal using multiple different techniques. The choice of which method to pursue is, therefore, influenced by the properties of the metal or metals involved. The decoration on this small in-progress box (Fig. 7), formed from the argentium silver alloy mentioned above, will consist of a combination of repoussé and chasing, enhanced with gold inlay to emphasise various details through colour contrast. There are many ways to attach gold to silver. In this case, using a technique that relied upon heating would have weakened the relief decoration, so there was a risk that it would have been deformed when applying the necessary pressure to adhere the gold. Instead Dawn used a Japanese method, whereby the silver is first scored with a small chisel to create a rough surface, then the gold is gently tamped down into place. The technique creates a mechanical join between the metals. This demonstrates that having a single solution to hand is rarely enough for craftspeople, modern or ancient. Exposure to and development of different techniques allows smiths to make the best choice for their desired outcome.

Metals and Tools

The choice of which metal to work with immediately has many other impacts. The hardness of a metal dictates what tools it can be worked with and, since this varies across the different members of the metals' family tree, this can have an important impact on the choice of metals, techniques, and equipment. There are other more subtle differences that affect the choice and treatment of tools as well.

Metals with low boiling points can be problematic for craftspeople. Metals are, as you have seen already in this paper, regularly heated during manufacture, especially when annealing and soldering. For those processes, both gold and silver require temperatures that exceed the boiling point of metals like lead and tin. If there are traces of such metals, even as alloys, on the gold or silver during heating, the base metals first alloy with the gold or silver, then vaporise. This leaves behind pitting on the surface of the precious metals, damaging their aesthetic appearance, and in the worst case scenario can sometimes even create holes. In workshops where, for example, both pewter and silver are being worked side-by-side, it is necessary to either impose strict tool hygiene protocols, to keep them free of residue and avoid accidental transfer, or even have two separate sets of tools available.[40] Separate working areas are required, and this can even extend to differentiating workshops by metal type to prevent this problem.

Working with different metals also leads to different relationships with tools in other ways. Dawn's blacksmithing friends often tease her about the shiny condition of her silversmithing anvil and T-stakes, since non-ferrous metals, such as silver and copper, will take on any unevenness, pitting, or roughness from the surface on which they are worked on. If there is any dust or scratch marks, or even just a little bit of grit on the tools or anvil and stakes, these will show in the surfaces of these softer metals. Iron and steel are worked hot and in workshops using equipment that has rougher surfaces. Iron too will take on impressions of tool cleanliness, but as it is rarely finished to a mirror polish this is not so problematic. However, finishing tools for all metals,

[40] The number of tools associated with a workshop may, therefore, have little correlation with the number of people present, and instead be linked to the range of tasks undertaken in the space and the number of different metals being worked.

including steel, need to be kept clean to prevent them damaging the surfaces they are being used on.

Metals and Fuel

Another factor impacted by metal type is fuel, which differs according to the varying temperatures needed for the required processes. Kilns are only utilised for highly specialised purposes, such as for bonding stacks of dissimilar metal pieces to make *mokumé-gane* billets (see below). Iron and steel call for some of the hottest working temperatures, usually achieved by using a coal or charcoal fire with forced air flow to raise the rate of combustion. Modern blacksmithing workshops, therefore, follow a more traditional model, due to this strong thread of continuity. Smiths working with non-ferrous metals may use a charcoal fire or, more rarely, an alcohol flame lamp, but often modern metalworkers turn to various gaseous fuels, including acetylene/air, propane/air, propane/oxygen, and acetylene/oxygen, sometimes in conjunction with a blowpipe so the smith can use their breath for finer control. The required size of the flame (torch head) and concentration of air/oxygen within the fuel depend on the process underway and the type of metal used.

For example, when Dawn welds pewter, she works with a tiny acetylene/air flame for which the blue section is no longer than 7 mm to 9 mm. This provides a temperature of about 246 °C. More heat than that would puddle the pewter sheet and burn holes into the piece before the weld could take place. When brazing silver she uses the same torch again, but with a much larger flame, extending from 25 mm to 65 mm depending on the size of the piece so that the temperatures range from 650 °C to 750 °C. There are different grades of silver-brazing compounds, formed from varying alloys, which match the required temperature; also to be taken into account are colour differences when matching materials.

Gaseous fuels allow for much more precise control over flame temperature, length, composition, and targeted position than previously possible. This has opened up new possibilities in terms of what is achievable with processes like soldering and brazing. It also leads to fewer mistakes. Such differences in fuel choices are the reason why, when conducting experimental archaeology, it is important to try to make the procedure as close to the past reality as possible. With experiential archaeology, when participants are gaining a feel for the overall process, this is less important. However, when testing, for example, a specific *chaîne opératoire*, using anachronistic equipment can prompt misleading interpretations.

Working with Multiple Metals

As is already apparent from this paper, working with two or more metals simultaneously can be necessary in order to create an object that satisfies the desired specification. However, metals do not have to be physically joined together in order to interact in an intra-cross-craft way. This serving set (Fig. 8), consisting of a copper tray with sterling silver handles, a silver sugar bowl, a silver spoon, and a silver creamer, provides another example of how metals can be used together in a complementary way. All the pieces in this set that will come into contact with foodstuffs are made of silver, which has antimicrobial properties and low reactivity, making it an excellent choice from a food safety standpoint. The tray is not intended to be used as a dining utensil so, although copper would have been a poor choice for the other objects in this set, due to its unpleasant and sometimes harmful reactivity with foodstuffs, other factors made it an appropriate option for the tray. The flatness of the tray would demand many rounds of annealing, because of the likelihood that it would become warped and too springy during the initial shaping process, which is easier to achieve with copper than silver because the former does not require additional flux. Copper as a material is less expensive than silver. Finally, the copper and silver provide a pleasing colour contrast. Therefore, although the selection of silver for the utensils was primarily dictated by food safety, the choice of copper was influenced by crafting, cost, and aesthetic considerations.

The advantages for using copper to make vessels are so significant that smiths have found a way to circumvent its inherent food safety issues. This is exemplified by Dawn's next case study, a cooking pot (Fig. 8), made from heavy-gauge copper. Copper is especially ideal for cooking, because it is such a good conductor of heat. The interior of the pot appears silvery because it has been tinned: using a low heat, pure tin has been wiped onto the surface. Tin is resistant to most chemical corrosion, hence its widespread use for food storage cans. For the handle a stronger metal is required than either tin or copper, and bronze was chosen because it is a poorer conductor of heat. Brass would have been a suitable choice too but, despite both being copper alloys, bronze forges more readily than brass. This is directly connected to the metals with which the copper is alloyed; the tin in bronze is more malleable than the zinc used to make brass. Finally, copper was selected for the handle rivet; being softer than bronze it provided a soft malleable connection between handle and pot, as well as creating a nice colour contrast. Riveting was especially chosen because of its mechanical strength, particularly because this join is put under a lot of strain when the pot is full. Attempting to use a brazing alloy would have triggered a reaction with the tin coating, which would have led to the slow decline of the join. This pot, therefore, partners copper with tin, but in two quite distinct ways. This is a useful reminder of how complex the relationships between members of the metals' family tree can be.

Fig. 8. A – silver service set with copper tray featuring silver handles; B – tinned copper cooking pot with brass handle (photo by Kent Heimer).

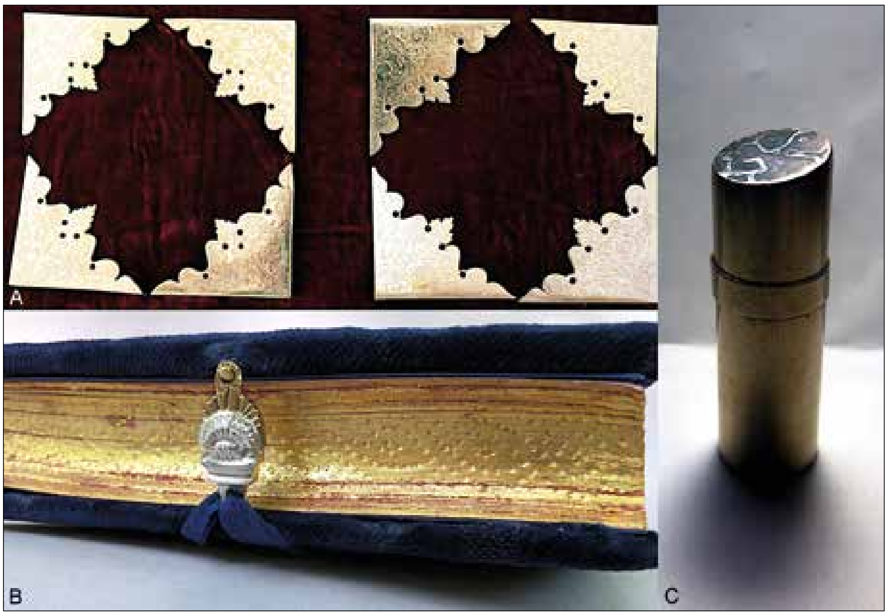

Fig. 9. A – reproduction gilt silver book furniture corner pieces; B – silver shell book clasp with brass back plate; C – perfumed oil box with *mokumé gane* decoration (photo by Kent Heimer).

Fig. 10. Three *mokumé gane* decorative boxes (photo by Kent Heimer).

Silver and brass can also partner well together, as demonstrated by this book clasp (Fig. 9). The clay/sand-cast sterling-silver shell was joined to the brass back-plate via diffusion; these two metals readily alloy together. The brass was then chased with a (harder) steel tool to echo and emphasise the grooves of the shell pattern. From a functional point of view, the brass is the better choice for the back-plate and peg because it naturally has a greater wear resistance compared to silver. From an aesthetic point of view, it shares the same golden colour as the gilt page edges, but provides an attractive contrast to the silver, making the shell stand out.

The dividers (Fig. 6) also incorporate multiple metals, the exact choice of alloys being founded upon a mix of traditional technical concerns combined with aesthetic considerations. This form of dividers was intended to be used to calculate locations whilst at sea by integrating observations with detailed physical maps. The use of brass for the hinge afforded a degree of resistance against corrosion stimulated by the salty maritime environment, whereas steel was favoured for the leg ends because its durability protected the sharpness of their points, ensuring the accuracy and increasing the use-life of the dividers. The hinge and legs will be joined together using rivets formed of red brass wire (with a high copper content), which is suited to this purpose and also provides colour contrast. The Damascus steel similarly adds aesthetic interest, and will be complemented by the use of a *mokumé gane* rod to make the large-diameter rivet that joins the brass hinge pieces together.

Damascus steel is just one example of how metals can be used together in an intra-cross-craft way specifically for decoration. The Japanese technique *mokumé gane* ('wood grain metal') layers together many metals which are then manipulated (*e.g.*, gouged or chiselled to reveal lower layers, deformed, then repeatedly hammered and/or re-rolled back into sheet) with the final stage being the abrasion of the surface, through filing and sanding, to reveal the pattern, which often resembles wood grain. Conceptually, it is the non-ferrous equivalent of Damascus steel. *Mokumé gane* is generally applied to decorative works, such as this small tubular box for perfume oil (Fig. 9) and these boxes made from copper and fine silver or brass (Fig. 10) because it is not food-safe, unless only silver, gold, and/or palladium alloys are used. The small tubular box (Fig. 9) incorporated many layers of sterling silver, brass, and copper alloys. The idea was to use a contrasting decorative surface to accent the sloped top of this simple form. Similarly, the use of an all-over pattern on the other decorative boxes called for a simple shape, with the top of these boxes calling attention to their details (Fig. 10).

Choice of metals can of course be guided primarily by the status of the patron or the receiver. In this case, the craftsperson must find ways to satisfy these requirements, even though they may raise difficulties during the production stage. This is exemplified by these silver and gold corner pieces (Fig. 9), which are reproductions of book furniture first made for the English queen, Elizabeth I (AD 1558–1603).[41] The selection of gold and silver were inevitable, because of the status of the recipient; only they would have been considered suitable metals capable of enhancing the splendour of the book. What is particularly intriguing is that mistakes were made in the engraving (which Dawn faithfully replicated), yet the pieces were still used for what was a very prestigious object. Dawn produced the corner pieces from fine silver (99% silver), engraved them by hand, burnished them with agate, and then gilded them.

Originally this was achieved through mercury gilding using pure (24 carat) gold,[42] a process in use from the Medieval era onwards.[43] Mercury gilding was applied to all manner of different objects, including steel armour and silver jewellery, as well as book furniture. Mercury is a very special member of the metals' family tree; the only metal liquid at room temperature, past artisans capitalised on its low density and boiling point to use it to deposit films of precious metals, like gold and silver, onto another metal surface. Mercury gilding required mixing and heating mercury with gold to form an amalgam paste, which was then wiped onto the surface to be covered. The object was then gently heated (340 °C) to evaporate the mercury, leaving behind a thin film of gold that was strongly bonded to the underlying metal.

Unfortunately mercury fumes are highly toxic, and mercury is rarely used in modern metalworking. Safer alternatives have been developed, although great care still needs to be taken when dealing with the fumes and chemical solutions required, including wearing protective clothing. This is one reason why electroplating is so popular now, but of course this process was not available prior to the 19th century AD.[44] Dawn was able to devise an alternative gold wipe to replicate the effect without resorting to mechanical gilding, by employing the basic principles of electroplating. She applied a plating solution containing 24 carat gold suspended in an electrolytic solution using a positively charged wand wrapped in a fibre cloth, and wiped it across the negatively charged silver piece. This wipe gave the same texture as mercury gilding, but without the danger of toxic mercury fumes. The plating solution used is still poisonous, as it contains arsenic, but using a wand rather than an immersion bath slightly lessened Dawn's exposure risk as less of the plating solution was required.[45]

Another important difference between modern and older gilding methods is that modern platers often sandwich a layer of zinc in-between the metals. This is to prevent the gold gradually self-alloying with the silver over time and becoming noticeably lighter in colour.

Finally, it is worth reiterating that metals are used in an inter-cross-craft, as well as an intra-cross-craft way, and often the metal itself only plays a supporting role. The entire design of this box (Fig. 11) revolved around the large slab of tiger's eye, which the client desired to be treated as the central feature. Both the shape and the colour of the stone was taken into account, with the patina applied to the copper made to match the rind/matrix of the material on the outer surfaces of the stone. Stones are often used in conjunction with metal, often for decorative purposes, such as for jewellery, but also for functional purposes, such as a handle. As an example, this replica of an 18th-century drawing tool, a porte crayon (Fig. 11), encloses the mineral graphite, which at the time was relatively rare and expensive, within a brass holder, produced by turning, and ornamented with hand-formed details, with a ring to hold the graphite in place.

This inter-cross-craft element can also be less visible in the finished piece. It is not uncommon for Dawn to

[41] The originals reside in the Folger Shakespeare Library (Washington DC), no. STC2099 Copy 3.

[42] Also known as 'fire gilding'. The process can also be applied to silver and is known as mercury silvering.

[43] Although Pliny describes a process of gilding using mercury, this was cold mercury gilding, a process that fell out of fashion once hot mercury gilding (fire gilding) was developed, which produced a better result (Vittori 1979, 35–36).

[44] Electroplating creates a differential charge between the object to be plated and the metal intended to plate it, with the latter held in solution (usually referred to as a bath). The positively charged particles of the covering metal are then drawn to the negatively charged substrate. Metals commonly used for plating in this way include silver, copper, and zinc chrome.

[45] The hazardous nature of certain metallurgical procedures, like fire gilding, means that completely accurate archaeological reconstruction of such processes, *i.e.* with little or no safety precautions, is not tenable.

Fig. 11. A – copper box with tiger's eye stone; B – reproduction brass porte crayon (photo by Kent Heimer).

begin 'making' a metal artefact by working with paper or clay, producing patterns or drawings for instance.

Final Thoughts

We hope that taken together the nine case studies discussed in the second half of this paper provide useful illustrations of the thought process that underlies decisions of which metals to combine and why. Although the use of modern knowledge, tools, materials, and facilities means that Dawn's experiences are not universally applicable to all archaeological contexts, the challenges presented by the working properties of the metals themselves are the same, and increased awareness of their implications can only improve our understanding of past metallurgical practices. This is just a small snapshot of the great complexity presented by the metals' family tree and the overwhelming number of opportunities they offer. The variation between the properties of metals is precisely the reason for using them together, even if this also precipitates new problems that need to be solved, as discussed here. Combining this vast potential with materials beyond their family tree has led to the endless possibilities that enable metals to enrich our lives in countless ways. For Dawn, this means she feels privileged to have had the chance to explore the variety of ways to exploit these special characteristics of metals, and to find ways to make useful and beautiful items for our world in which we live.

Author Roles

Dawn Hoffmann: concept, design of experiential guide, production of experimental pieces, writing of initial draft;

Stephanie Aulsebrook: extension and editing of text, referencing, bibliography, image editing.

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The Coroplast and the Potter: Considerations on Cross-Craft Specialists

Abstract

Coroplastic studies is a vibrant area of research among material culture specialists dealing with the ancient world. With terracotta sculpture ranging in size from miniature to over lifesize, various techniques were employed in the crafting of distinctive products. Use of clay demanded facility with the hands as well as the employment of other technical devices. It is clear from the study of how terracotta sculpture was made that many of the techniques used for fashioning objects were similar to those employed by potters. The votive terracotta sculpture discovered at ancient Marion, one of the city kingdoms of Cyprus during the Iron Age, will form the basis of the discussion. With a corpus of over 30,000 fragments, the material represents the largest cache of sculpture in clay from a single site on the island. Local production is assumed from the volume of the material as well as the presence of nearby clay sources. Detailed assessment of manufacturing strategies reveals production affinities with various stages of clay procurement methods, techniques for material preparation and the utilisation of various formation practices including hand building, coil and slab construction, and use of the wheel – all schema shared by both coroplasts and potters.

Keywords: potter, clay, terracotta, coroplast, Cyprus, Marion, mould, handmade, coil, wheel

Introduction

Although artisans produced some of the most splendid works that reflected the creative genius of the ancient world, quite little is known of the makers of works of art across a geographic and chronological spread. This is especially true in the ancient Mediterranean, where the status of most artisans was relegated to that of a craftsman, whose low social standing belied the skill that often resulted in the production of objects that reflected expert workmanship.[1] Mention of renowned artists in ancient texts, such as by Pausanias in *Ἑλλάδος Περιήγησις* and Pliny in *Naturalis Historia*, resulted in later scholarship that privileged artistic genius, obviating the contributions made by lesser-famed individuals whose works were acquired by a clientele to satisfy religious, funerary and domestic needs.[2] How such artisans practised their craft has been eclipsed by the *lacunae* of technical manuals, save for references to the now-lost treatises credited to masters such as Apelles (composition and painting), Agatharchos (perspective), Euphranor (symmetry and colour), and, of course, Polykleitos (sculptural proportion).[3]

The presence of small-scale establishments focusing on particular media has been the accepted reality of artistic production in the ancient Mediterranean, with the existence of more sizeable operations assumed for eminent artists whose reputation and success garnered lucrative commissions and generated product demand.[4] Archaeological investigation has increasingly made possible the identification of workshops devoted to pottery and coroplastic production, and the expansive crafting and export of ceramic wares and terracottas, especially

[1] Bourriot 2015; *contra* Seaman 2017b, for elite and renowned artists; also Loomis 1993, 83–91.
[2] Seaman 2017a.
[3] Hasaki 2012, 172; Seaman 2017b, 19 n. 70.
[4] Ling 2000.

from Athens and Corinth, have added to what is known about pottery and terracotta production.[5] Other sites in the Greek world have also contributed to the discussion of pottery and coroplastic operations.[6]

In addition to documented artisan facilities, recent scholarship has focused on the investigation of craft process whose reconstruction has been facilitated by multidisciplinary approaches that include the examination of archaeological remains, use of textual sources, representations of craft activities, epigraphic evidence, archaeometric analysis, social network theory, ethnographic study and experimental archaeology. Some of those methodologies are exemplified by contributions in this volume, and the massive scholarly bibliography that is now available reflects critical literature for an evolving credible reconstruction of the reality of craft production in antiquity.[7]

The discussion that follows represents a consideration of two different craft industries practised widely in the ancient world: pottery and clay sculpture. The commonality of the raw material – clay – warrants investigation of a relationship that might have existed between potter and coroplast and whether the processing of materials, implementation of specific technical strategies, execution of manufacturing procedures, indeed, the distinct *chaîne opératoire* requisite in ceramic production and the fashioning of clay sculpture suggest a correspondence in workshop practices and personnel for two different craft industries.[8]

Evidence for the physical presence of coroplast workshops is less extensive than for pottery establishments; nevertheless, sites of coroplastic activity have been posited for diverse regions throughout the wider Mediterranean on the basis of specialised equipment (moulds, levigation basins) and materials (pigments, clay supplies, figurine deposits).[9] Workshop activity often is surmised by the number of figurines, both intact and broken, discovered at a site, with local production suggested by the quantity of excavated artefacts and the relative consistency of fabric. That is the case with two ancient cities in Cyprus, Marion and Arsinoe, where an extraordinary corpus of terracotta sculpture has been recovered. The extensive study of that material provides new insights into how coroplasts practised their craft and implemented technical strategies shared with potters – in essence, how craft symbiosis may have effectively functioned.

Background

The ancient sites of Marion and Arsinoe are located on the north-west coast of Cyprus (Fig. 1:A-B), and both were well-established cities beginning in the Iron Age and continuing into the medieval period.[10] Marion, the earlier of the two, was one of the ten city kingdoms of the island during the Cypro-Archaic and Cypro-Classical Periods and flourished until 312 BC when it was destroyed by Ptolemy I Soter in the wars of the Diadochi after the death of Alexander.[11] Arsinoe was the successor city, founded in 270 BC by Ptolemy II Philadelphos and named after his sister/wife; the city's fortunes varied, and it was ultimately superseded by the modern town of Polis Chrysochous.[12] Both sites have been the focus of archaeological excavation, but a long-term programme of coordinated work by Princeton University was begun in 1983 and continues to the present.[13]

During the course of excavation, an enormous quantity of terracotta sculpture was discovered – over 30,000 fragments, with material associated with both cities. The majority of the sculpture derives from two Iron Age sanctuaries that had functioned while Marion was thriving before its destruction.[14] The earlier of the two, the Peristeries sanctuary (Fig. 1:C), known by its toponym, is a multi-phased, rural sanctuary dedicated to a female divinity with fertility associations dating to the Cypro-Archaic Period and destroyed in the early 5th century BC. Within the complex and the adjacent *bothros*, over 25,000 fragments of terracotta votives were recovered, with the majority having stylistic and typological parallels with the Levant and Egypt. The second Marion sanctuary, the Maratheri sanctuary (Fig. 1:D), was also multi-phased, dated to the Cypro-Archaic and Cypro-Classical Periods, and was destroyed in 312 BC by the soldiers of Ptolemy I. Within the temple, the forecourt and the intervening space next to the city wall, among the votive offerings

[5] Stillwell 1948; 1952; Young 1951; Stillwell, Benson 1984; Jones 1986, 175–189 (Corinth), 153, tab. 10.2 (Athens); Arafat, Morgan 1989, 314, 317–319; Merker 2000; 2003; Monaco 2000; Papadopoulos 2003; Acton 2014, 72–115; Hasaki 2021, 227–278; Rotroff 2021; also Heilmeyer 2004 for precautions in site identification.

[6] Miller 1991; Blondé, Perreault 1992; Cuomo di Caprio 1992; Preka-Alexandri 1992; Doulgeri-Intzesiloglou 1997; Kourkoumélis, Domesticha 1997; Pisani 2008; 2012a; 2012b; Esposito, Sanidas 2012; Murphy, Poblome 2016; Bentz 2019. I am deeply grateful to the anonymous reviewer of this article for these sources.

[7] Uhlenbrock 1993; Rebay-Salisbury *et al.* 2014; Muller 2017.

[8] Merker 2003; Koukouvou 2017.

[9] Higgins 1967, 137; Uhlenbrock 1990; Sanidas 2017.

[10] Nicolaou 1976a; 1976b; Childs *et al.* 2012.

[11] Childs 1997; 2012.

[12] Childs 1988; Najbjerg 2012; Papalexandrou, Caraher 2012; Serwint et al. in press.

[13] Smith 2012.

[14] Smith *et al.* 2012.

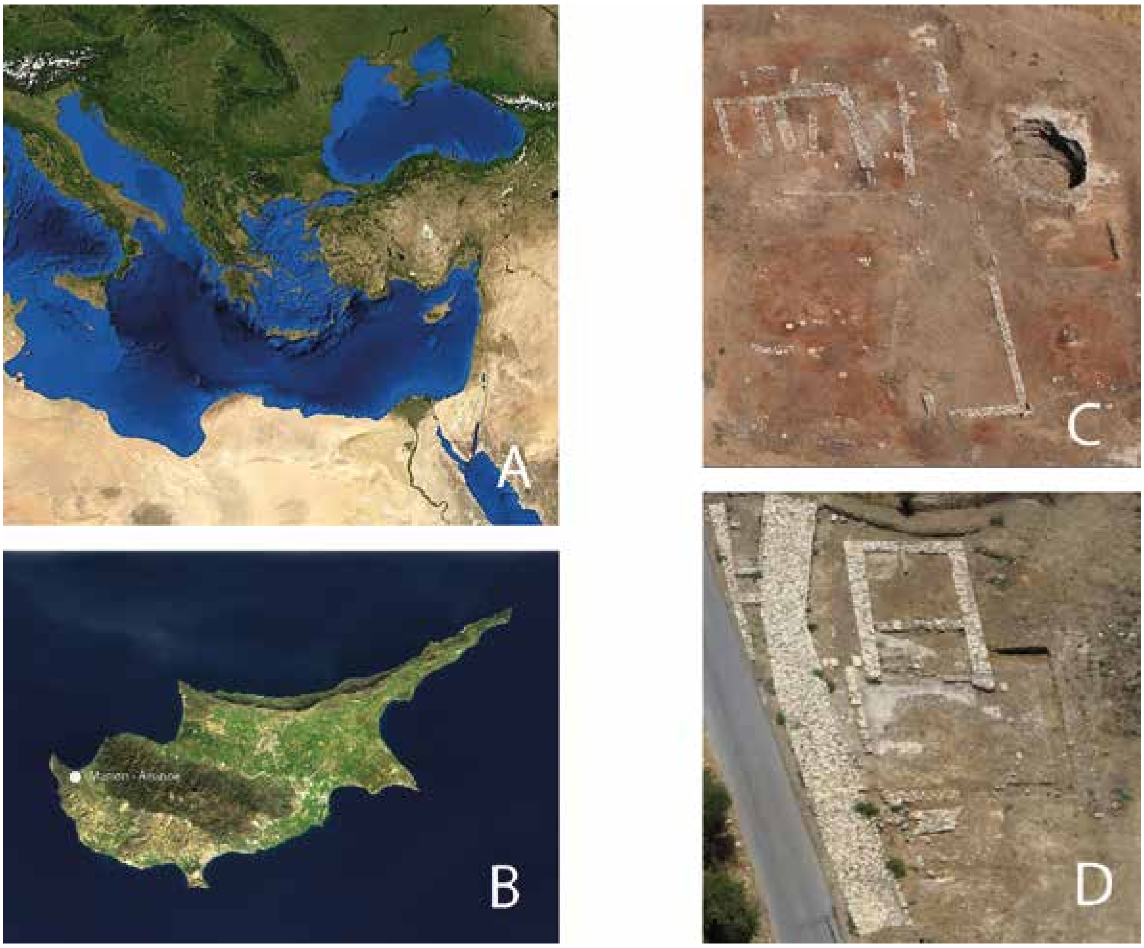

Fig. 1. Cyprus (Marion-Arsinoe) and Marion sanctuaries: A – satellite view, Mediterranean Sea (https://commons.wikimedia.org/wiki/File:Mediterranean_Sea_16.61811E_38.99124N.jpg); B – satellite view of Cyprus, Marion and Arsinoe, NASA Earth Observatory (https://eoimages.gsfc.nasa.gov/images/imagerecords/1000/1343/modis_cyprus_lrg.jpg); C – Marion, Peristeries Sanctuary (photo courtesy of Princeton Cyprus Expedition); D – Marion, Maratheri Sanctuary (photo courtesy of Princeton Cyprus Expedition).

were nearly 5,000 fragments of terracotta sculpture. The sanctuary was dedicated to Aphrodite and, possibly, Zeus, and in style and type, the sculpture had affinities with East Greece and the Greek mainland.[15]

The terracotta sculpture from ancient Marion and Arsinoe provides an ample corpus that allows for a study of coroplastic material from diverse perspectives. The massive quantity is exceptional as the largest cache of clay sculpture yet discovered in Cyprus. The secure context affirms the votive nature of the objects, while the corpus reflects robust typologies. Dating is confirmed by historical corroboration as well as dated parallels with pottery and other diagnostic sculpture from outside the island. The range of object size includes miniature to over-lifesize,[16] while the duration of production extends over the span of several centuries from the late 7th century BC into the Roman period, permitting an evaluation of how style and morphology changed over time. Assessment of the clay and the volume of the corpus suggest local production. Close examination of the sculpture has revealed different production strategies that included various procedures that served the skill of the coroplast, the availability of materials and the demands of the market. What is significant is that many of the techniques used to fashion clay sculpture were the same as those employed by potters in the manufacture of ceramic wares.

[15] Serwint 1991; 1992; 1993; 2000b; 2008; 2020; Smith *et al.* 2012.

[16] Serwint 2000a.

Technical Strategies

The Marion-Arsinoe terracotta corpus reflects the most widely used technical strategies employed by coroplasts: handformed, mouldmade and wheelmade approaches. Often multiple methods were used in the crafting of a single object, and study of a finished object might reflect diverse ways as to how the clay was handled. Objects similar in size and sharing a common typology sometimes reveal different crafting strategies, which may suggest the work of different artisans, although a coroplast was always free to adopt different ways of making the same type of object. Close visual examination of an object allows for understanding of how a coroplast worked: oftentimes traces of finger pressmarks are visible on the surface; the remains of coil seams might be apparent; and wheelmarks might remain. Critical is the examination of both the exterior and the interior of an object, and a skilled coroplast would be far more careful to remove traces of his work on that part of an object that would be readily seen, so the back and the interior of a clay sculpture can reveal much about process. Visual examination can be enhanced by using a magnifying glass or handheld microscope, as not all traces of an artisan's work are apparent to the naked eye. It is equally important to handle an object in order to determine how a coroplast worked. Particularly with handbuilt objects, it is essential to remember that a coroplast was touching and holding his work at various stages of the construction process while the clay was still moist. Pressure from the fingers will leave subtle furrows in the clay, and noting where they occur allows a researcher to establish how an ancient artisan held the object and how it was positioned in his hands. Often it is possible to determine whether the object had been held in the right or left hand while being crafted, indicating which hand of the artisan was the dominant one.

In addition to careful study of the object, experimentation in replicating how an object was created by using clay or plasticine is an invaluable activity to aid in understanding various coroplastic procedures. Replication allows one to intuit the logical steps of the process, and by trial and error, one learns how a coroplast worked most effectively. Study of traditional crafts, especially pottery making, is essential for understanding coroplastic processes because of the close correspondences between methods employed by potters and coroplasts, and critical reading still remains the analysis of methods used in ancient vase construction.[17]

Handbuilding

The most basic tool used by both coroplasts and potters were the hands, and hand construction was the primary and most expedient way to craft terracotta sculpture and pottery before the introduction of the wheel. Handcrafting was accomplished in different ways, and basic approaches were hand assembly, coiling and slab construction. Various sizes of objects could be constructed, and all methods were detected in the Marion corpus.

Hand Assembly

As a technical process, hand assembly could be the sole method of creating a terracotta object or it could be used with other manufacturing procedures (Fig. 2). The most simple way to craft a figurine was by an additive process of combining separately made component parts to create the whole. Known as the "snowman technique", body parts and headgear were fashioned individually and then added to complete the figurine (Fig. 2:A, B). Beginning with a clay roll that served for the body and head, the neck was configured by simply pressing the side of the forefinger into the roll, forming an indentation. Separate clay rolls were affixed to fashion the arms and variously positioned depending on the required pose. Additional clay was used to form eyes, nose, breasts, headgear and accoutrements. The technique of hand assembly was the earliest and most simple method of crafting a terracotta figurine, and at Marion, it was the method of choice for the production of the earliest figurines dating to the late 7th century BC and continued to be useful for coroplasts even when the mould was introduced at the site in the 6th century BC. There is an interesting correspondence between figure and pottery especially during the Early Bronze Age in Cyprus. The scenic compositions that decorated Red Polished Ware vessels reflect a fluid merger of figure and vessel,[18] and since both were constructed by hand, a single artisan might well be responsible. When a coroplast worked on a larger scale, simple finger manipulation of the clay and basic handforming were no longer practical, so different

[17] Numerous publications that document processes used in pottery formation and sculpting clay are available. Most informative are: Peterson 1992; Piepenberg 1998; Midgley 1999; Taylor 2011; Serwint 2022. For discussion of ancient pottery construction, see Noble 1988; Schreiber 1999. Significant resources on ceramic technology are Shepard 1985; Rye 2002; Rice 2005. Essential ethnographic studies are numerous, but for Cyprus see London *et al.* 1989; Ionas 2000.

[18] Morris 1985, 264–290.

Fig. 2. Handbuilding strategies: A – female figurine, R11681, Peristeries Sanctuary (photo by N. Serwint); B – male figurine, R1753, Peristeries Sanctuary (photo by N. Serwint); C – handforming clay vessel (http://www.eastonmainstreet.org/events/working-clay-for-beginners-2019-08-23/); D – handforming clay vessel (https://liberty.armymwr.com/calendar/event/boss-hand-pottery-class/5644005/67193).

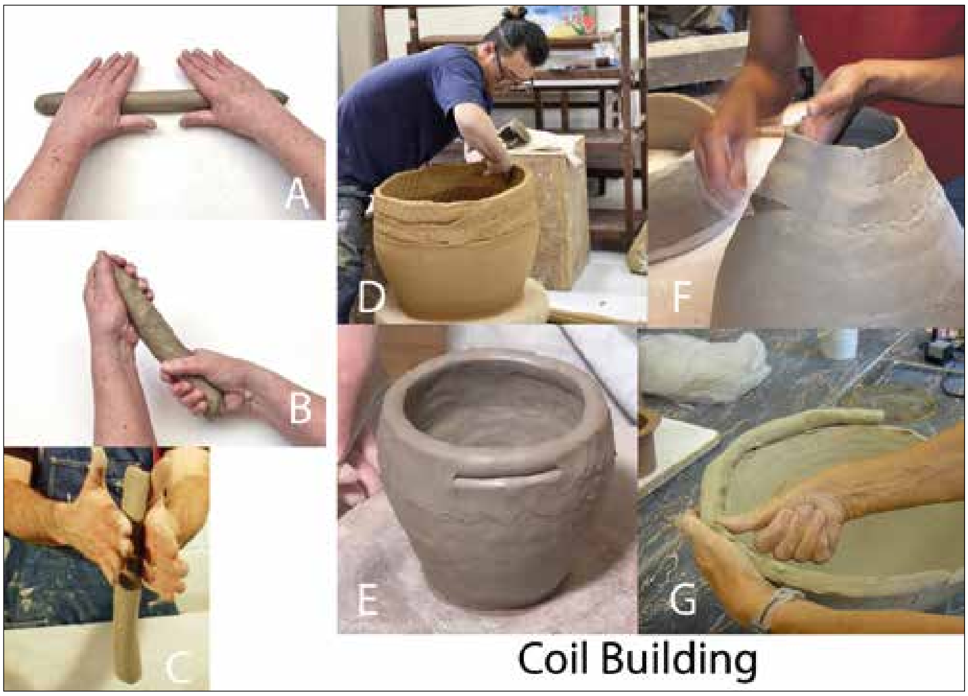

Fig. 3. Coil building: A – rolling a clay coil (https://www.jansonpottery.com/blog/how-to-make-a-coil-pot-for-beginners-2); B – pulling a clay coil (https://www.jansonpottery.com/blog/how-to-make-a-coil-pot-for-beginners-2); C – making a clay coil, vertical hang (https://www.open.edu/openlearncreate/mod/oucontent/view.php?id=162581&section=2.6); D – Korean Onggi pot made with coils (https://www.quora.com/What-is-the-basic-materials-for-a-beginner-in-pottery); E – masking coil seams (https://thepotterywheel.com/smooth-coil-pots/); F – making large jug with coils (https://ceramicartsnetwork.org/daily/article/How-to-Make-a-Coil-Pot-Using-Flat-Coils-to-Construct-Large-Jars); G – making large vessel with coils (https://en.wikipedia.org/wiki/Coiling_%28pottery%29#/media/File:Aufbaukeramik_Wulsttechnik_7.JPG).

strategies were developed that were more efficient and time-saving.

Coiling

A very common handbuilding technique is coiling (Fig. 3). It remains an effective method in pottery construction for the formation of large vessels, and a coroplast would have adopted the method for crafting large, hollow, circular or oval forms. After making coils (either on a flat surface, rolling clay in the hands, or rolling clay in the hands vertically with gravity pull (Fig. 3:A, B, C), a coroplast would position the coils end to end in a circular or oval configuration as required by the shape of the sculpture. The sequential addition of coils overlapping the top of the layer below proceeds until the desired height is achieved (Fig. 3:D, E, F, G).[19] It is critical to squeeze the juncture of coils on both the interior and exterior to guarantee the sturdiness of the form, and added clay helps secure the join and mask coil seams. Depending on the height of the form, it is common that after the construction of four or five layers of coils, the form is left to dry somewhat before the application of additional coils; this prevents the form from slumping and collapsing from added weight. Once completed and when the clay is relatively hard, the exterior surface is finished by scraping perpendicular to the coil seams, and often faint traces of vertical tooling or the striations left by the passing of a moistened cloth over the surface are visible.

Coiling is the most time-consuming process of handbuilt strategies and the one that requires great effort on the part of a coroplast, although if done correctly, it results in a sturdy form. Consequently, the method is preferred by both potters and coroplasts for the crafting of large, hollow objects.

The coil technique was used for the construction of several large statues at Marion (Fig. 4). The over-lifesize, male Egyptianising statue (Fig. 4:A, B, C) is a composite of several separately made parts, and the torso is comprised of three stacked, elliptical drums (Fig. 4:A, B).[20] Each drum was constructed by coils, and peg holes with indented channels matched similar holes and channels at the same place on contiguous drums (Fig. 4:B, C). Once the drums were stacked on top of each other with the indented channels in alignment, the coroplast would have placed a leather cord – or perhaps a metal strip – into the indented channel, inserting the ends into the adjacent peg holes, and twisting or affixing the ends on the interior of the drum. A simple smear of clay would then be added to mask the channel cut. The technique provided extra stability to a heavy statue. Significant is that a very similar technique was used by potters to join fragments of a broken vessel together, and it is telling that the same method for joining was employed by both coroplasts and potters.

Coil construction was also used in the crafting of a lifesize female statue that was a votive offering in the Marion Maratheri sanctuary (Fig. 4:D, E, F, G). Only the front of the statue carried surface decoration, while the back did not, which will be discussed in the section below on slab construction. On the back, minimal surface smoothing is visible, although the back remains somewhat rough. Visible on the lower left back, coil seams are readily apparent, indicating the coroplast's failure to adequately join adjacent coils (Fig. 4:E, G).[21]

Slab Construction

Another handbuilding method that was useful for crafting large objects was slab construction. Formed by rolling or pressing clay on a flat surface (Fig. 5:A, B), a slab could be easily configured into the desired thickness required by a coroplast. Often crafted into rectangular shapes, slabs were joined together by pinching and squeezing the ends of adjoining slabs (Fig. 5:C).[22] Forms could be easily fashioned, and the technique was employed for sculpture of statuette or statue size and for body parts of some breadth, like torsos and backs. Although more versatile and quicker than coil construction, the sturdiness of the form was compromised by the use of a single clay slab as opposed to the durability achieved from joining multiple coils, and the thickness of a slab was much less than the wider girth of coils. After a slab was formed and allowed to harden slightly, it could be readily shaped into a cylindrical or semi-circular form, useful for the crafting of limbs.[23]

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[19] Sequential rows of coils might be positioned directly on top of each other, but this is far less stable than having the coil rows slightly overlap, thereby increasing the surface area of contact. Pressing the coil seams together with the application of added clay strengthens the join. This is the usual placement of coils in pottery manufacture, and likely coroplasts followed suit. See Shepard 1985, 57–59, 184–185; Rye 2002, 67–69; Blandino 2003; Rice 2005, 127–128; Taylor 2011, 62–65.

[20] The statue is calculated to have stood at 3.00 m in height; the variation in the colour of the drums is due to various conservation techniques by different conservators. On the interior of the drums, gentle, parallel horizontal undulations are visible that confirm the joining of coil seams; see Serwint 2000a.

[21] Measurements of the width of coils on the back of the statue ranged from 3.83 cm to 4.48 cm, indicating that coil widths were not consistent.

[22] Rye 2002, 71–72; Rice 2005, 124–125; Taylor 2011, 70–71.

[23] Slab construction is sometimes used by modern potters to form mugs, cups and vases, but whether ancient potters used the method for making pottery is uncertain.

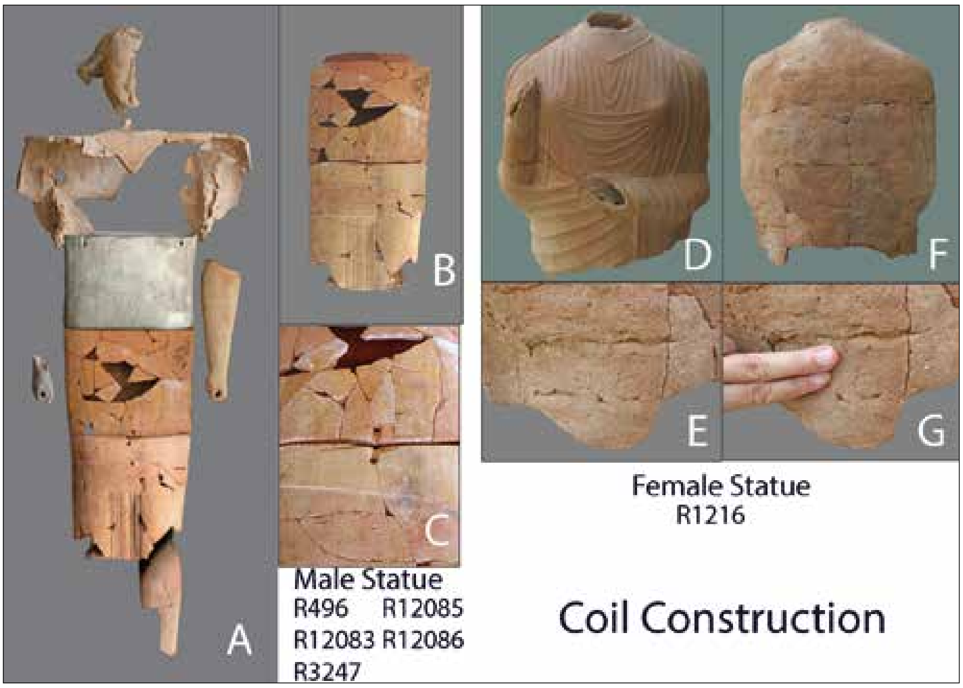

Fig. 4. Coil construction: A – colossal Egyptianising statue (photo courtesy of Princeton); B – torso drums, R12085, R12086 (photo by N. Serwint); C – torso drums with adjacent peg holes and channels, R12085, R12086 (photo by N. Serwint); D – lifesize female statue, front, R1216 (photo by N. Serwint); E – coil seams on statue back (photo by N. Serwint); F – lifesize female statue, back, R1216 (photo by N. Serwint); G – coil seams on back of statue (photo by N. Serwint).

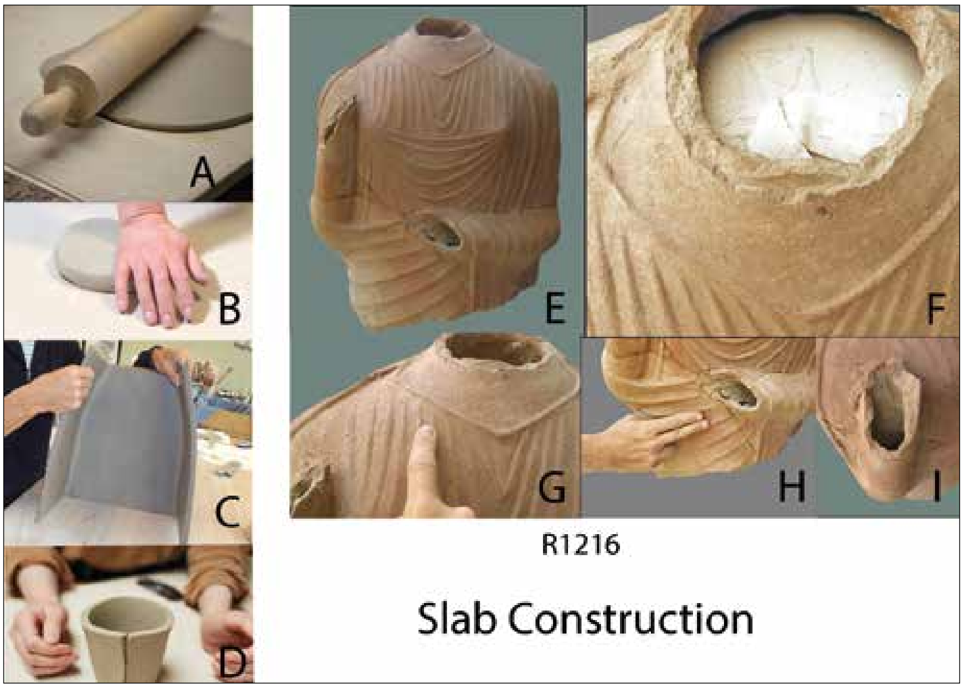

Fig. 5. Slab construction: A – rolling a slab (http://redandthepeanut.blogspot.com/2017/02/how-to-make-ceramic-pottery-lily-pad.html); B – pressing a slab (https://thepotterywheel.com/slab-plates/); C – large slab construction (https://www.lakesidepottery.com/Media/JPG_Images/custom-made-trophy/28-stand-up-side-down.jpg); D – bending a slab (https://www.handthrown.studio/studionews/2020/4/27/handbuilding-from-home-how-to-make-a-mug); E – lifesize female statue, front, R1216 (photo by N. Serwint); F – front of statue, detail showing presence of slab (photo by N. Serwint); G – front of statue, detail showing drapery formation (photo by N. Serwint), H – front of statue, detail showing drapery formation (photo by N. Serwint); I – proper right arm, detail showing slab construction (photo by N. Serwint).

Various terracotta votives from Marion were made from slabs, and an excellent example is the lifesize female statue (R1216) previously discussed (Fig. 4:D, E, F, G; Fig. 5:E, F, G, H, I). The arms were fashioned from clay slabs that were configured into half cylinders and attached to the front of the torso (Fig. 5:H, I). An unusual use of a clay slab was a thin sheath of clay that was added to the front of the coil-made torso, which is seen clearly at the break at the neck (Fig. 5:F). The application of the outer clay slab, present on the front of the torso and not the back, allowed for the articulation of drapery folds and rills. Using the thumb and forefinger to pinch the clay to form drapery folds, the same fingers were drawn through the clay to create furrows between folds (Fig. 5:G, H). What is most interesting is that detailed measurement of all the folds revealed that the width of the furrows was always the same as the width of an adult finger or multiples of digits. In order to create a narrow furrow, the tip of the forefinger was used; in instances where the fold widened, the angle of the forefinger to clay was decreased to an acute angle, with the coroplast using the pad of the finger tip and part of the underside of the finger to draw through the clay. When wider folds were required, the thumb was used or multiple fingers in combination.

Wheel Construction

A coroplast did not always solely use handbuilding strategies to craft a clay sculpture but might rely on mechanical means as well; the use of a potter's wheel was a significant asset. There are numerous examples of terracotta figures and larger sculpture where evidence of wheel use can be readily identified, which again suggests a close relationship between coroplast and potter. Even though a coroplast might be proficient in using his hands to manipulate clay to craft an object, a different skillset is required to handle clay on a rotating wheel, even the slow-moving wheel employed by ancient potters. Although a necessary piece of equipment in a potter's workshop, a wheel need not be essential in the place where a coroplast worked. A coroplast might solicit the help of a potter when faced with the task of creating an object that required the use of a wheel or might be provided access to a wheel by an accommodating potter. Either scenario is possible and, indeed, feasible because of the documented close proximity of workshops of potters and coroplasts in antiquity.[24]

Throwing clay on the wheel required a different plasticity of the material than was necessary for handbuilding, and a coroplast, if, indeed, he was responsible for wheel construction, would have had to know his material well.[25] Different parts of the process, such as centring, opening, lifting, shaping and removal from the wheel demanded very specific ways of using one's hands, and any artisan who used the wheel would have to be skilled in the process in a way that an artisan who engaged only in handbuilding was not.

Wheel construction could be used for various sizes of objects that were cylindrical in shape, and it was particularly effective for larger forms (Fig. 6:C). Limbs, both arms and legs of statuettes and statues, were easily formed on the wheel.[26] Smaller objects, such as figurines or those of figure size, could be partially wheel-crafted if the form was hollow, as was the case for tubular lower bodies of humans, flaring skirts of female figures and some animal bodies.[27] Although wheel-thrown elements could be part of coroplastic production, it would be unusual for this to be the sole technique used in crafting an object, and handbuilding and wheel use were often used in tandem.

The telltale sign of wheel use is the presence of wheel marks, known as rills, which are the repetitive ridges and grooves that spiral around the exterior and interior of a wheel-made form during the process of lifting and raising the clay (Fig. 6:A, C).[28] Irregularities on the exterior of the form are usually removed while the object is still on the wheel, with the artisan applying the side of a sharp tool to the surface while the wheel remains turning, which smooths and evens the form (Fig. 6:B). It is quite common that the walls of a wheel-thrown form are thicker at the base and thin towards the top. Among the Marion votive corpus, there are many examples of wheel construction used for the production of clay sculpture and best seen on the interiors of arms and legs of several large statues, all of which are lifesize or larger (Fig. 6:D, E, F, G, H, I). R1640 (left arm and fist) clearly shows the repetitive sequence of wheelmarks on the interior (Fig. 6: D, E), while R12083 (Fig. 6:H, I), a lifesize lower leg, bears ample traces of the wheel on its interior surface. The nearly twice over-lifesize fist (R2087; Fig. 6:F, G) bears the remains of rills on what is left of the lower arm. In all cases, the coroplast was careful to remove wheelmarks on the exterior. Limbs such as these, made on the wheel, would have been added to body parts – torsos or thighs – that likely were fashioned from coils or slabs.

[24] See note 5 above.

[25] Shepard 1985, 50–54.

[26] Karageorghis 1993, 102–105.

[27] Higgins 1967, *passim*.

[28] Rye 2002, 74–80; Rice 2005. 129.

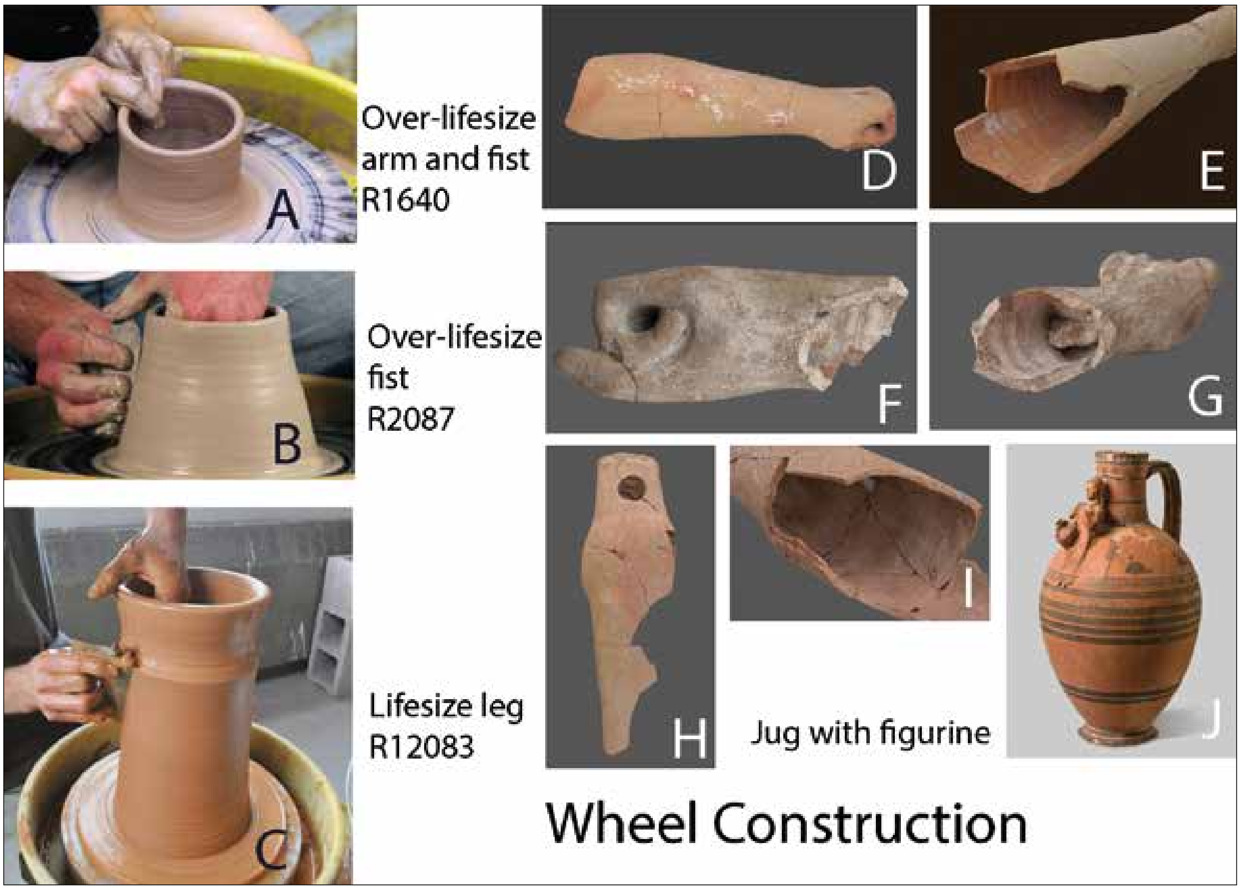

Fig. 6. Wheel construction: A – throwing on wheel (https://thepotterywheel.com/what-is-wheel-throwing/); B – smoothing exterior (https://ceramicartsnetwork.org/daily/article/Wheel-Throwing-in-Cross-Section); C – throwing large vase on wheel (https://ceramicartsnetwork.org/daily/article/Wheel-Throwing-Video-How-to-Throw-a-Large-Vase-on-the-Pottery-Wheel); D – over-lifesize arm and fist, exterior, R1640 (photo by N. Serwint); E – over-lifesize arm and fist, interior, R1640 (photo by N. Serwint); F – over-lifesize fist, exterior, R2087 (photo by N. Serwint); G – over-lifesize fist, interior, R2087 (photo by N. Serwint); H – lifesize leg, exterior, R12083 (photo by N. Serwint); I – lifesize leg, interior, R12083 (photo by N. Serwint); J – jug with figurine, MMA 121, Marion-Arsinoe Archaeological Museum, Polis (photo courtesy of Princeton Cyprus Expedition).

The wheel allowed an artisan to quickly create a cylindrical form that could be modified to shape a leg or arm. By applying finger pressure after formation on the wheel, the diameter of the clay cylinder could be easily altered to replicate the natural variation of the breadth of the limb. The girth of a lifesize statue torso precluded the effective use of the wheel, and coil construction was the norm for very large-diameter cylindrical or oval forms. Certainly, wheelmade forms could be more rapidly constructed than those made from coils; however, coil fabrication ensured a solidity of finished product that wheel construction could not guarantee.

Use of a Mould

Although the use of a mould is not associated with pottery manufacture, in the production of terracotta sculpture it became the most common method of crafting figurines, and its relevance to this discussion will become apparent below. When the mould was introduced into the Mediterranean world sometime during the 7th century BC as a technical device, it totally revolutionised the coroplastic arts and how terracotta sculpture was made. Prior to that time, all forms would have been hand assembled.[29] However skilled a coroplast might be, it was

[29] Sporadic use of the mould prior to the 7th century BC has been documented for Crete: mouldmade Late Minoan IA bull *rhyta* were found on Pseira, and Late Minoan moulds were discovered at Gournia for the production of clay and faience objects; see Higgins 1967, 12.

a time-consuming process to form separate elements by hand that would comprise clay figural sculpture of any size. With the introduction of the mould, certain elements were not only quickly and efficiently made, but multiples could be formed with very little effort as long as a mould remained serviceable. The use of a mould ultimately caused an explosion in the coroplastic industry: increasing the popularity of small-scale figurines, expanding the repertoire of affordable products, developing a consumer appreciation for refined aesthetic forms and stimulating dissemination of *au courant* styles across a broad geographic area.[30]

At Marion, it is possible to trace the trajectory of mould use, which likely was consistent with the employment of the mould elsewhere in the ancient world. At first the mould was limited to the crafting of the front of the face, with the rest of the head and figure fashioned by hand.[31] Only later was the mould used for the front of figurines (first females, and a bit later, males), and it was only in the 4th century BC that double moulds were utilised for both the front and back of figurines. Thereafter, multiple moulds were used for different parts of a figurine: head, body and limbs. Mould use did not necessarily require a coroplast to be a sophisticated artisan because any refinements in style of drapery, coiffure and facial features were the result of the archetype or *patrix* that was derived from either an existing figurine or object crafted in some other medium over which a coroplast had no control. Filling a mould derived from an archetype required little skill, and it is only when coroplasts became more inventive with the use of multiple moulds for different body parts that creativity was expressed in various poses and gestures as opposed to the potential of a dull repetition of the same figurine.[32] Possibilities of variation were great, and at Marion the range was staggering, with 37 different moulded face types and 67 separate drapery variations for female figurines dating to the 5th and 4th centuries BC.

The issue of mouldmade figurines and the relationship between coroplasts and potters becomes significant because of a very special class of Cypriot pottery that has been associated first with Marion and then subsequently found at sites in the western part of the island.[33] The vessel type is a jug, primarily Bichrome red ware, decorated with a figure or figures holding a juglet on the shoulder of the vessel. The vessel type was popular from the end of the 6th century BC until the Hellenistic period (Fig. 6:J). Moulds were often used to craft the faces, and sometimes the torsos of the figurines, and what is interesting is that parts of many of the figurines on the vases were the same as moulded figurines in the Marion votive corpus, indicating that the same mould had been used for both objects. The question arises whether a coroplast and potter collaborated together to produce the Marion vase with figurine or did the potter have access to the same mould that a coroplast also used to fashion a votive figurine. In essence, was the vase made by one artisan or two?

Conclusion

Potters and coroplasts were craftsmen allied with each other because of material shared in common. In order to be successful in their work, each artisan had to possess knowledge of the properties of clay. The ultimate form of any object that was produced demanded that both potter and coroplast had expert familiarity with how a clay fabric responded to technical strategies, especially in terms of the plasticity of clay and how any given clay recipe would perform during firing. At Marion, a local coroplastic industry is likely because of the volume of votive sculpture in clay that has been recovered in excavation, and although not discussed in this paper, the amount of plain ware pottery found at the site indicates that many vessels were locally produced as well. In sum, both potters and coroplasts worked in the area, and this is corroborated by the discovery of a kiln, a settling basin associated with clay purification, numerous wasters, several figurine moulds and various lumps of mineral pigments that were suitable as colourants for both pottery and clay sculpture. There is not enough available information to suggest how many artisans might have been active at Marion, but the size of the terracotta corpus would certainly argue for an active industry that was comprised of coroplasts with a range of skills. Study of the material already has identified distinct ways in which different bases were crafted for figurines, preferences for solid versus hollow figurines, and unique ways that the interiors of various larger objects were marked and treated by their makers. This, of course, argues for the presence of different and distinct craftsmen. Literature on ceramic and coroplastic workshops posits that staffing was limited to five or six individuals, and a division of labour allowed for tasks to be assigned to workers of various skill levels. Since the mining of clay, preparation of workable fabrics, acquisition of fuel as well as kiln construction and firing were all requisite steps in the ceramic and coroplastic industries, the possibility of shared labourers would be a sensible economic strategy.

[30] Muller 2000.
[31] Serwint 2022.
[32] Uhlenbrock 1990.
[33] Vandenabeele 1998.

It is documented that potters in ancient Athens did not necessarily specialise in a single form but were adept at making a variety of wares, and that some named artists assumed the role of both potter and painter.[34] Studies that have been undertaken that posit networks and associations that existed among distinct potters indicate that linkages among those in the ceramics industry were numerous and far-ranging.[35] That such involvement would have existed for potters and coroplasts who worked in close proximity is certainly likely. Because of the dearth of named coroplasts, it is not feasible to construct professional networks among coroplasts; however, the burgeoning field of forensic studies that investigates finger impressions on ancient ceramic materials holds much promise.[36] Initial scanning of fingerprints left by coroplasts on the Marion votive corpus began in 2019 before the pandemic, and renewed study by this author will be extended to include finger impressions on pottery in the hope that the dataset will allow for confirmation whether potters worked on figurines and coroplasts on ceramics. That potters and coroplasts collaborated closely is quite certain at Marion, and certainly likely elsewhere in the ancient Mediterranean. Continued study promises to detail just how extensive those partnerships were.

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[34] Rotroff 1997, 72–77.

[35] Harris Cline, Hasaki 2019.

[36] Jägerbrand 2007; Muller 2017, 159; Lichtenberger, Moran 2018.

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Marble Extraction and its Industry: a Multidisciplinary Case Study of the Vathi Quarry on Tinos Island[1]

Abstract

Through an analysis of the tool marks, imprints on the parent rock, unfinished objects, and the waste left behind, quarries provide a wealth of information about the organisation, manufacturing process, transportation, and the broader stone trade and production they supported. Adopting an intra-cross-craft approach, scholars studying stone craft can gain a deeper understanding of the various stages of production, starting at the primary level of the quarry and the more expansive stages of artefact production. Recent investigations on the island of Tinos have brought to light several quarries that had not previously undergone in-depth exploration. This paper considers such a newly examined quarry as a case study. Through an interdisciplinary methodology, it aims to present new perspectives on both the ancient and modern marble industries in the Cycladic Islands. This paper seeks to expand our understanding of the marble terrain in each region from a range of topographical, archaeological, geological, and historical perspectives and highlight the use of marble with unique qualities, extraction techniques, and production processes.

Keywords: Quarry, technology, marble, geology, Cyclades, Greece

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Introduction to Marble Extraction

The large-scale extraction of marble as a raw material began with the extensive construction of monumental religious architecture in Greece during the Archaic period. Stone construction evolved considerably starting in this period, eventually supplanting wooden architecture, which had been the norm. Quarrying and stonemasonry activities were at that time also becoming central to community identity. The main Greek quarries were fully active in the 6th century BC (*e.g.*, Naxos, Paros, Thasos, *etc.*).[2] With a few exceptions, there were no new quarries or stone processing technologies during the Hellenistic period, with production and extraction limited to the small, local scale. These exceptions were Penteliko near Athens and the quarries of Paros. During the Roman period, quarrying continued in large quarries, and many more quarries were opened due to increasing demand. These central facilities remained integral to the Roman Empire's marble supply chain, working alongside smaller local quarries to facilitate the widespread distribution of this important raw material.[3] The methods of stone extraction and the tools utilised changed depending on the material and its properties, personal preferences, experience, and training of those working in the quarries, and the customer's priorities. In short, to extract the marble block from its parent rock, craftsmen had to know and consider the length of the natural cracks and identify the right location for placing the wedges and the levers. Then, deep holes were cut in the rock. Metal wedges had to be tested to fit in each hole. After the extraction and the first phase of processing the volume (removing unnecessary material to make the transfer easier), the unfinished object was ready for transport. The transport was completed by sea or land, depending on the location of the quarry. For example, quarries near the sea offered a significant advantage due to the cost-effectiveness of short- and long-distance sea shipping compared to land transport.[4]

Typically, quarries were organised to include several key components such as the extraction area, debris dump, sliding ramps to the storage platform, storage platform and the position of the hoisting machine, tool repair workshops, the sacred area containing a small sanctuary, workers' accommodation, guard tower, and loading area.[5] These characteristics could be altered according to the local infrastructure, the locality, the nature of the quarry, and whether the quarry was meant to be temporary or permanent. Once the quarry was selected, depending on its location and the quality of the marble, with the necessary elements in place, the preparations for the extraction of the raw material could be started.[6]

The methods of stone extraction, as well as the tools, changed according to the material (marble, granite, *etc.*), the personal preferences, experience, and training of the quarrymen, and the customer's order. However, some general steps had to be followed for this procedure. Quarrying was undertaken with the quarry pick and possibly with a pointed chisel and wedges.[7] A pointed chisel and a hammer would be used to define the soon-to-be extracted block, and some of the larger unnecessary parts of the stone blocks would be removed. At this point, the blocks would start gaining their shape.[8] The main characteristics of the marble extraction process were the ease or difficulty of splitting the marble in each direction, knowing how to exploit this quality, the faults hidden within the stone, and its resilience, purity, and responsiveness to the precision workmanship. As soon as the trench was cut, shallow holes – either round or square – would be carved out at the bottom of the block while it was still attached to the parent rock. Wedges would be placed within these holes and hammered until the block was split from the rock.[9]

Introducing the Case Studies on Tinos Island

The island of Tinos, located in the Aegean Sea in Greece, is the fourth largest island in the northern Cyclades (Fig. 1). Archaeological research on Tinos is limited compared to other Cycladic islands. However, current interdisciplinary studies have contributed significantly to a better understanding of the cultural and historical importance of the island of Tinos throughout history.[10]

In recent years, scholarly attention has been directed towards meticulously examining distinct marble production centres from antiquity, specifically within localised settlements. The process of ordering raw materials and trading this product still remains a multifaceted endeavour, encompassing intricate relationships with the quarry, quarrymen, customers, and geographical considerations of the mobility and transport of this raw material, as well as seasonality. Different markets retailed different

[2] Waelkens *et al.* 1988, 14–15.
[3] Fant 2008, 122–135.
[4] Fant 2012, 528–532.
[5] Koželj 1988, 31.
[6] Koželj 1988, 32.
[7] Wootton *et al.* 2013a; 2013b.
[8] Rohleder 2001, 70–72.
[9] Korres 2000, 16.
[10] For a similar interdisciplinary approach to a quarry study, see Anevlavi *et al.* 2021.

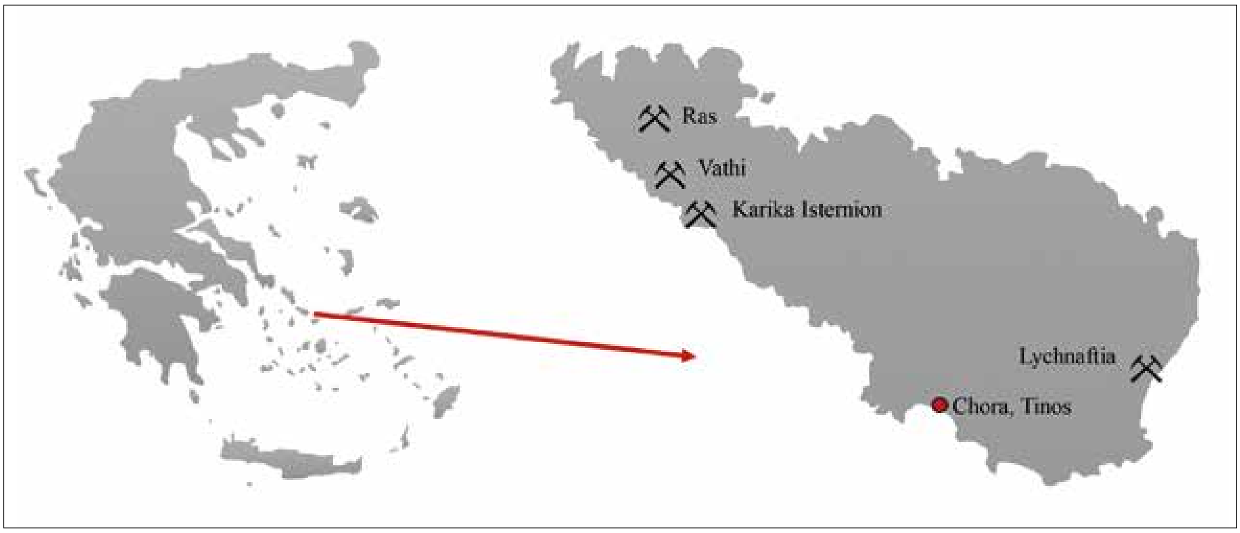

Fig. 1. Map of Tinos island (edited by T. Jakobitsch, V. Anevlavi; ÖAI/ÖAW).

kinds of marble objects. Their needs were shaped by the demands of specific styles dictated by customers and the larger social and cultural shifts in the region. Production centres and local workshops were located throughout the ancient world, usually near urban centres. Major marble production hubs were favoured as primary sources of raw materials. The practice involved transporting the raw materials from these central locations to the respective workshops. In the meantime, the production proceeded according to each period's traditional, local decorative designs and patterns.

Three case studies on the island of Tinos are currently being investigated, focused on white marble and green serpentinite quarries. The first case study is the Ras quarry (serpentinite). Ras (only ancient use) is a very small quarry of serpentinite rock with traces of ancient tool marks. Extensive ancient quarry facades, several metres high, are visible, with traces of pick marks. The serpentinite from Ras exhibits a unique texture, with a bright/light green serpentine network developing within the massive dark green serpentine matrix, and it differs from the currently quarried ophicalcite (Tinos Verde). Small concentrations (< 1%) of other minerals include talc, chlorite, and iron oxides.[11] The site consists of two small-scale open pits facing north and south, respectively, and two areas of debris (pit A: 228 m^2; pit B: 121 m^2; debris pile A: 456 m^2; debris pile B: 808 m^2).

The second case study, the marble quarry in Karika Isternion on Tinos, is particularly interesting for the present research context. It is one of the most important ancient quarries on the island, with traces of recent quarrying, as it was in operation until 1950–1951. The quarry, now inactive, operated in the late 1990s as an aggregates quarry. Within the boundaries of the modern inactive quarry and covering an area of at least 10 hectares, numerous and extensive ancient quarry faces are visible, sometimes several metres high, with traces of quarry picks. Characteristics include trenches for separating the stones from the parent rock and holes for inserting round wedges. Unique for Tinos, but also a significant finding for the Cyclades in general, is a 7–8 m high and 16.30 m long rock face on which a series of engraved inscriptions (graffiti) have been preserved. The marble in this quarry is white with grey parallel veining.[12]

This paper presents information concerning the third quarry from this group, the Vathi quarry. Our goal for this pilot study has been to examine its diachronic use and geochemically fingerprint the area in preparation for future archaeometric investigations. As part of this research, we have identified several key questions which are fundamental to understanding this quarry and marble quarrying on Tinos more generally:

1) What are the characteristics of each quarry?
2) How do the quality and material conditions act as decisive criteria for the processing and specific usage of white marbles?
3) How was the demand for marble on Tinos met? Were the local quarries mainly used for their marble needs?

[11] Sideridis *et al.* 2025.

[12] The current location is under study by V. Anevlavi, S. Kravaritou, and A. Angelopoulou.

4) How did Tinos fit into the stone trade's overall development trajectory and its relationship with supra-regional marble quarries such as Prokonnesos, Thasos, Penteli, *etc.*?
5) What was the usage of the local and imported types of marble in architecture on Tinos (structural elements, decoration, furnishing, *etc.*), and what were the criteria for these choices?

The investigation of manufacturing in the past through cross-craft interaction has provided a better understanding of the linkages between various crafts and their implications for the final product. Based on the intra-cross-craft process, our research combines information on quarries, mining, and transportation techniques, and tools and tool marks in various stone (and especially marble) quarries in antiquity. Not only was Tinos one of the main marble production centres, but it is also the birthplace of many sculptors of the 19th and 20th centuries, providing masterpieces across the Eastern Mediterranean. By investigating the crafting process of ancient artefacts and their provenance, we aim to connect ancient sculpting traditions with the continuity of quarry extraction, the location of the stone sources, the use of the material, and traditional sculpting knowledge on the island throughout the centuries. The critical exploration of marble remnants derived from notable structures and artefacts on Tinos Island will be integral to our forthcoming research.

The Vathi Quarry, Tinos

Vathi quarry has many characteristics of a typical quarry organisation (Fig. 2). Vathi produces a white marble with grey parallel veins and fine- to medium-grained size, while the upper layer is gneiss.[13] The main facade is approximately 80 m^2. The known height of the facade is 17 m, while the longest preserved length is 30 m. In the northern part of the facade, one can observe scattered blocks of diverse sizes, marked with distinctive pick marks and wedge holes.

Extensive modern activity has been conducted in the area both before and after World War 2, significantly impacting the quarry. The cutting of an opening into the mountain has disrupted the pristine facade. According to local workers, this opening was cut for investigative purposes, aiming to assess the breadth of the marble layer and explore the feasibility of explosive extraction.[14] The original size of the facade has also been modified by modern debris from activity last century, as well as more recently (2021). The extraction waste was used for small-scale building construction. In that way, the quarry was kept clean from the continuous production of debris, and, at the same time, small facilities were created for the workmen. This extensive modern activity has erased any possible ancient tool marks. No ancient traces can be seen in the modern passage to the port. However, the current transport route may be based on the ancient one. The walls along this path are constructed with debris.[15] Additional information about the Vathi quarry is provided by a previous study by Florakis,[16] who examined the quarry's use during the 19th century and extracted information and photographs from the archives of the local workmen and owners.[17]

Relative Chronology of the Vathi Quarry

The Vathi quarry on the island of Tinos presents two main geological formations: an upper dark brown gneiss layer and a white marble formation underneath, both with evident traces of extraction. The geological information is given below. Although a substantial part of the two superposed formations is visible, it is no longer possible to appreciate the full extent of the extraction fronts. This is because the quarry is undergoing significant transformation due to new extractions nearby, with the old quarry being filled with vast amounts of rubble from this new exploitation. As already noted, the maximum height of the white marble extraction front still visible today is 17 m.

Extraction Traces in the Gneiss Layers

Although most of the extraction traces are visible in the white marble formation, it is important to determine whether the covering dark brown gneiss formation was also quarried for stone production or whether it was just eliminated to access the white marble formation. At about 1/3 of the total height of this formation beneath the rock surface, traces of the cutting of a vertical extraction trench are preserved along this facing (Fig. 3:A, B). This trench was cut with a quarry pick, and the face of the quarry worker was directed to the southwest side of the quarry front. This can be deduced from the curvature of the individual traces of the quarry pick. This trench must have had a sufficient width, allowing the quarry worker to move within it (about 60 cm wide[18]) because

[13] Florakis 2005, 17.
[14] Florakis 2005, 15–21.
[15] No ancient characteristics can be observed.
[16] Florakis 2005, 19.
[17] Florakis 2005.
[18] Doperé 2012, 113; Doperé 2013, 203; De Ceukelaire *et al.* 2014, 48; Doperé 2014, 62, 64.

Fig. 2. The main facade of the Vathi quarry (photo by V. Anevlavi and T. Jakobitsch; ÖAI/ÖAW, ©Ephorate of Antiquities of the Cyclades).

the upper part of the traces is situated under a small overhang of the layers. Such traces could not have been generated unless the quarry worker stood within the trench. It is difficult to understand why they did this, but the fragility of part of these layers could have prompted them to do so. Several metres below these traces, another similar series of quarry pick traces is visible. Given their proper extraction, the presence of at least two traces of a vertical extraction trench shows that stone blocks were carefully isolated from the surrounding rock formation.

Compared to the irregular rock facings immediately below the top rock surface, it is clear that the vertical flat facings between them and the traces of the above-described vertical extraction trench were quarried as well. However, no extraction traces are visible because the natural fracturing of this rock formation was used to split blocks by simply using a lever. It is clear that both techniques, extraction trenches and levers, were in use for the extraction of blocks in this gneiss quarry. The last horizontal extraction surface, before the final destruction of this quarry, descended according to a slow, roughly stepwise slope from top left to bottom right (Fig. 3:A).

The Destruction of the Gneiss Quarry

This gneiss quarry was abandoned and destroyed to allow rapid access to the underlying white marble formation. The destruction was done systematically by deep, mechanically drilled circular perforations, thereafter filled with explosives. These vertical perforations can be easily seen in the whole zone between the original slope of the quarry and the top of the marble layer (Fig. 3:A). Therefore, it can be concluded that the activities in the first gneiss quarry came to an end because priority switched to the extraction of the white marble formation. Mechanical drilling and using explosives to eliminate the gneiss cover and quarry were part of the extraction process at the end of the 19th and early 20th centuries.[19] This also marks the start of the extraction of the white marble formation underneath.

The Extraction of the White Marble

All the white marble extraction fronts show parallel horizontal linear extraction traces (Fig. 4:A, B) made with a quarry pick. They resulted from cutting vertical extraction trenches between the blocks and the quarry wall while the quarry worker was standing above his trench with a quarry pick. Where the pick hit the wall of the trench, a line was slowly formed by a tight succession of point impacts (Fig. 4:B). The surface in between the successive lines (about 4 cm) shows the negative traces of upward flaking, each time starting from the new bottom of the trench, while this was progressively deepened out. At first sight, the white marble extraction front shows a quite uniform distribution of the parallel horizontal

[19] Doperé 2012, 125; De Ceukelaire *et al.* 2014, 54; Doperé 2014, 92.

Fig. 3. Vathi quarry on Tinos, the upper gneiss quarry: A – below and left are vertical linear traces of mechanical drilling for explosive quarrying; B – the traces of the quarry pick (photo by V. Anevlavi and T. Jakobitsch; ÖAI/ÖAW, ©Ephorate of Antiquities of the Cyclades).

lines. However, at regular heights, a more roughly treated horizontal band is characterised by fewer parallel lines, sometimes crossing each other, and additional traces of the pointed chisel (Fig. 4:A, C). These coarser horizontal bands correspond to the places where the extracted blocks, already primarily detached from the quarry wall by the vertical extraction trench, were finally broken away from the wall just beneath the deepest point of the extraction trench. Such a break-off zone appeared near the bottom part of the extracted blocks because the set of horizontally placed iron wedges (see below) was put in place somewhat lower than the deepest point of the extraction trench.[20] After the extracted block was lifted from the quarry, the irregularities on the wall caused by this breaking-off had to be rectified with the pointed chisel to allow the further deepening of the extraction trench for the following block to be extracted below the previous one.[21] These more irregular bands can be distinguished on the wall because they are darker due to a more intense shadow created by the coarser treatment of these zones (Fig. 4:A, C). The top bed of the extracted blocks was carved with a pointed chisel.

[20] Doperé 2012, 103–104; Doperé 2013, 187–190; De Ceukelaire *et al.* 2014, 49; Doperé 2014, 59.

[21] Doperé 2012, 103–104; Doperé 2013, 188–189; De Ceukelaire *et al.* 2014, 49; Doperé 2014, 54, 56.

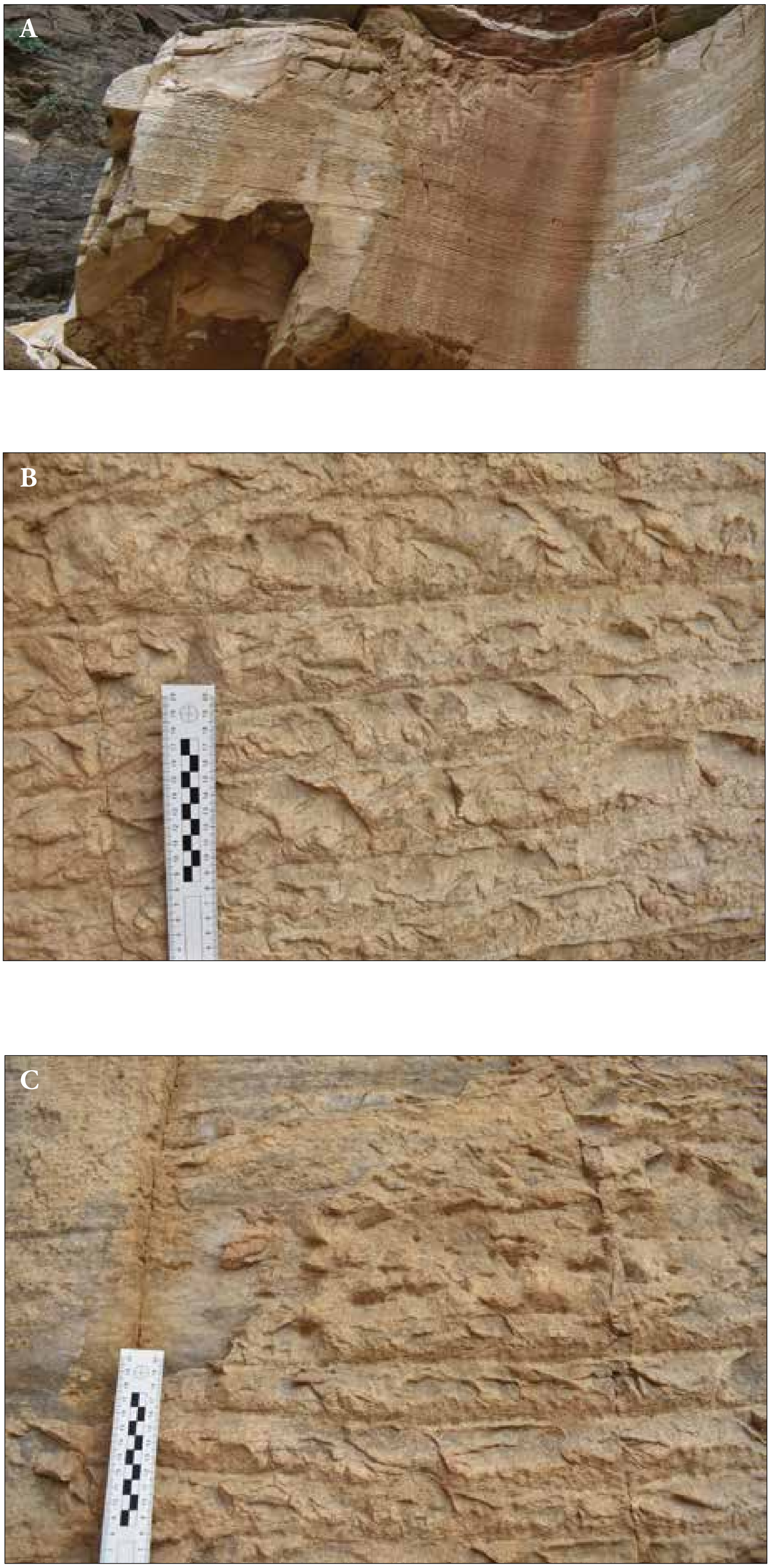

Fig. 4. Vathi quarry on Tinos, the lower white marble quarry, curved part: A – horizontal parallel extraction traces of the quarry pick. The darker horizontal zones correspond to the rectification of the break-off zones with the quarry pick and the pointed chisel; B – horizontal parallel extraction traces of the quarry pick; C – horizontal parallel extraction traces with the quarry pick (below), the rectification of a break-off zone with the pointed chisel (central zone) (photo by V. Anevlavi and T. Jakobitsch; ÖAI/ÖAW, ©Ephorate of Antiquities of the Cyclades).

Fig. 5. Vathi quarry on Tinos: A – block ready to be detached with iron wedges. Rectangular wedge hole carved at the basis of the block; B – four wedge holes with, each time at the right side, a mechanically drilled hole, and at the left side, the proper wedge hole with the traces of carving with the pointed chisel (photo by V. Anevlavi and T. Jakobitsch; ÖAI/ÖAW, ©Ephorate of Antiquities of the Cyclades).

The triangular wedge holes were either carved horizontally or vertically (Fig. 5:A). They were created first by mechanically drilling a horizontal or a vertical circular hole (diameter: 3 cm, depth: 12 cm), followed by the triangular enlargement of the wedge hole with the pointed chisel (Fig. 5:B). This tool was moved obliquely downwards towards the drilled hole. This procedure was repeated three to four times until the depth of the drilled hole was reached. The block to be extracted was then separated from the rock formation underneath or from a vertical wall by introducing a set of iron wedges so that in the quarry (not visible) and on the extracted blocks, half wedge holes remained visible until their final dressing.

The technology of vertical extraction trenches made with a quarry pick was in use during Classical Antiquity.[22] However, mechanical drilling and explosives eliminated the natural rock between the described sloping of the gneiss quarry and the white marble layer, indicating that the white marble quarry is relatively recent. Also, the special technology for carving wedge holes, starting with mechanical drilling, points to a relatively recent chronology. This modern use is confirmed by the dates 1858 on the lintel of the door of one of the houses and 1889 on top of the marble quarry wall, which point to a late 19th century start for the white marble extraction. There is no visible evidence to attribute part of this white marble quarry to Classical Antiquity. Further archaeometric investigations on marble artefacts (well-dated objects) from Tinos, Delos, and the surrounding islands could confirm a possible ancient operation date at this location.

[22] Bessac 2020, 34.

The Destruction of the White Marble Quarry

Today, the white marble quarry itself is being partly buried under debris from a new extraction point. On the right side, southwest of the old quarry, a new extraction point is active, using deep vertical parallel, closely contiguous drilling holes. These series of drilling holes are the recent versions of the more classical vertical extraction trenches. In the meantime, the older white marble quarry front is degrading because of natural fracturing. Some other parts of that quarry were recently destroyed perpendicular to the main white marble wall.

The Geology of the Island of Tinos

For this new study, it is imperative to understand the geological features of the island and their role in the historical extraction of raw materials. Tinos is part of the Attic-Cycladic Crystalline Belt (ACCB), consisting of two tectonic units (Upper and Lower). The ACCB is the result of the convergence and final collision of the Eurasian plate and Apulian microplate during the Tertiary Period, inducing the high temperature-pressure Eocene metamorphism during subduction (giving rise to the formation of the Cycladic Blueschist Unit – CBU) in the region of the south Aegean.[23] This high-grade metamorphic event was succeeded by a greenschist facies overprint during the Oligocene-Miocene, during the exhumation of the sequences.[24]

Three main tectonic units have been recognised on Tinos:[25]

1) The Upper Tectonic Unit (UTU) comprises a metamorphosed dismembered ophiolite complex that is believed to have been metamorphosed under greenschist facies.[26] At these high structural levels, researchers also include the metamorphic Akrotiri Unit.[27]
2) The Lower Tectonic Unit (LTU) or Intermediate Unit is the most voluminous Unit of Tinos and hosts significant marble occurrences (forming three main horizons)[28] along with a variety of metasediments and metabasalts that have reached high pressure (CBU) and subsequent greenschist retrograde metamorphism.[29] The marble-schist sequence represents the original stratigraphic sequence of their sedimentary rock precursors.[30] The sedimentation ages of the LTU are of, maximum, Late Cretaceous age, whereas older ages were yielded for the parts near the base of the Unit, with a clear depositional gap being noted.[31] Isotopic data from the marbles rate $\delta^{13}C(PDB)$ between 1.1 to 2.7 and $\delta^{18}O(PDB)$ between -1.7 to -11.4.[32]
3) The Basal Tectonic Unit (BTU) outcrops in the northwest part of Tinos are dominated by dolomitic marble and phyllites metamorphosed in greenschist facies.[33]

Both the UTU and the LTU have been intruded by the Miocene Tinos Pluton.[34]

The Geochemical Fingerprint of the Vathi Quarry

The importance of coloured marble as a valuable material and commercial product is undeniable in cultural-historical heritage research, and many studies have been devoted to this topic. However, white and whitish marble present significant difficulties when tracing their origin due to their lack of macroscopic solid features and relatively homogeneous composition. Many studies have focused on this effort as the degree of difficulty is high and requires multiple combinatorial techniques. Systematic efforts in recent years have led to the discovery of a large number of quarries of white and whitish marble from antiquity, which broadens research with new hypotheses about the use and distribution of marble in each period and sets new goals in methodology, databases, and distinguishing of sources. For example, the 2003 publication by Lazzarini and Antonelli[35] presents information and physicochemical analyses from quarries on Tinos, more specifically in the areas of Patela (quarries and outcrops), the quarry between Agios Charalambos and Faneromeni, the quarry of Isternia, the quarry around Karelados, and the quarry around Pasalos. However, no reference is made in that publication to the area of Vathi.

The geochemical fingerprinting of the Tinian locations will expand scholarly knowledge and the already existing databases of ancient white marble, supporting future archaeometric investigation at the local and sub-regional scale. The team's current database contains

[23] Matthews *et al.* 1999; Matthews, Schliestedt 1984; Okrusch, Broecker 1990.
[24] Bröcker 1990.
[25] Breeding *et al.* 2003; Hinsken *et al.* 2016; 2017; Melidonis 1980.
[26] Breeding *et al.* 2003; Bröcker, Franz 1998.
[27] Patzak *et al.* 1994.
[28] Melidonis 1980.
[29] Bröcker *et al.* 1993.
[30] Bröcker, Franz 1998.
[31] Hinsken *et al.* 2016.
[32] Lazzarini, Antonelli 2003.
[33] Bröcker, Franz 1998.
[34] Mastrakas, St. Seymour 2000.
[35] Lazzarini, Antonelli 2003.

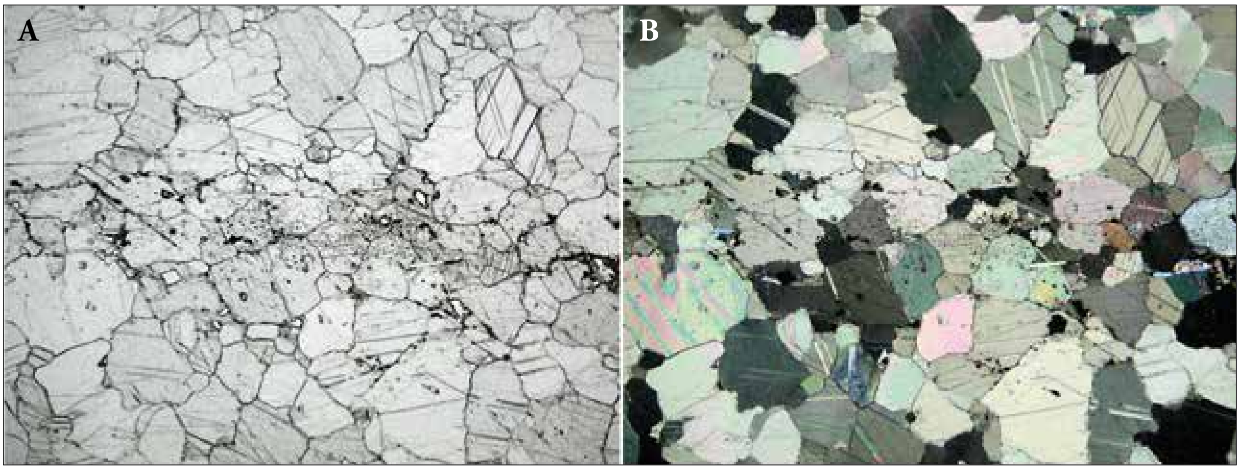

Fig. 6. Marble from Vathi quarry on Tinos: A – this marble generally exhibits a fine-grained heteroblastic texture where the larger grains (up to 1 mm MGS) occur in the very white layers or varieties (parallel light, the length of the image is 6 mm); B – along the schistosity, layers of a thickness up to several mm occur with dull calcite crystals due to the frequent occurrence of very small fluid inclusions in these crystals, most probably due to late fluid percolation along these shearplanes (cross-polarised light, length of the image is 6 mm) (photo by W. Prochaska; ÖAI/ÖAW).

about 5,700 quarry samples, covering the most important marble quarries from antiquity. The current data shows a particular density in Asia Minor (Dokimeion, Ephesus, Heraclea, Aphrodisias, Prokonnesos), where not only is regional classification already possible, but local quarries can also be differentiated from each other.[36] The database has been compiled from various studies over the last 20 years by Walter Prochaska (author) from the University of Leoben in collaboration with the Austrian Archaeological Institute in Vienna. The specimens are sorted in the repositories of the Austrian Archaeological Institute, and an open-access online platform with all relevant information is under construction.

For the present study, detailed sampling, recording, and identification of the chemical elements of the quarry at the Vathi sites were carried out. The analyses of these samples provide the geochemical fingerprint for the site and serve as a pilot study for future projects targeting the origin of marble archaeological artefacts.

The overall fabric of the Tinos marble is that of a slightly schistose rock, essentially made of calcite without any visible dolomitic component. This marble generally exhibits a fine-grained heteroblastic texture where the larger grains (up to 1 mm MGS[37]) occur in the very white layers or varieties (Fig. 6:A). The grain boundaries are modestly intermeshing. The MFG[38] is well below 1 mm. Along the schistosity, layers of a thickness up to several mm occur, with dull calcite crystals due to the frequent occurrence of very small fluid inclusions in these crystals (Fig. 6:B), most probably due to late fluid percolation along these shearplanes. Accessory minerals, mainly mica, quartz apatite, zircon, and organic matter, occur within these layers.

The geological samples were characterised by isotopic, chemical, and trace elements analyses (Tab. 1). More specifically, stable isotope analysis ($^{13}C/^{12}C$ and $^{18}O/^{16}O$), trace element analysis, and analysis of the fluid inclusions.[39]

The results obtained provide the unique geoinformation for the Vathi quarry. The analysis demonstrated that the staple isotopic values for oxygen are between -5 and -9.2, while the carbon values are between 0.8 and 2.3 (Fig. 7). The ion-chromatography data encompass lithium, sodium, potassium, magnesium, calcium, fluorine, chlorine, bromine, iodine-jod, nitrate, and sulphite ions in ratios, and DS (the amount of sodium, potassium, and chlorine in ppb in the extracted solution). The chemical values from the ICP-MS analysis include magnesium, manganese, iron, strontium, chromium, vanadium, yttrium, cadmium, boron, lanthanum, cerium, praseodymium, dysprosium, holmium, ytterbium, lead, and uranium (in ppm). The numerical data obtained

[36] A further 6,000 samples from various groups of artefacts from archaeological sites and museums, including sculptures, reliefs, sarcophagi, inscriptions, and particular architectural features, can be added to this database.

[37] Maximum Grain Size.

[38] Most Frequent Grain.

[39] For the detailed instrumentation reference and the sample preparation procedure, see Prochaska, Attanasio 2021; Prochaska, Attanasio 2022; Prochaska *et al.* 2024.

from this analysis will be systematically integrated with the relevant information from archaeological artefacts in our future research. Employing statistical comparisons, we aim to ascertain the provenance of these artefacts. It is crucial to highlight that, for a meaningful comparison, both geological and archaeological samples must undergo consistent treatment.

In this preliminary phase, we are now endeavouring to discern differences within the Tinos quarries through an examination of the isotopic data. Specifically, we focus on a comparative analysis between two Tinian locations, Vathi and Karika, and a significant Cycladic source located on the island of Paros. The selection of this initial set of locations lays the foundation for our future research. The rationale behind presenting this pilot study now is multifold. Firstly, it is a crucial exploratory step for insights into the isotopic variations between these locations. By doing so, we establish a baseline for validating the feasibility of our approach and discerning potential nuances within this Cycladic data. Secondly, by starting with a focused analysis involving Tinian locations and a notable Cycladic source on the island of Paros, we can highlight immediate patterns and variations that may exist. This focused approach allows us to draw initial comparisons and contrasts, paving the way for a more comprehensive future investigation. Presenting this pilot study now is strategic in the sense that it sets the stage for a more expansive research endeavour. As we move forward, our analysis will extend to incorporate additional sources from the island of Naxos, thereby expanding the geographic scope of our investigation. This phased approach enables us to incrementally build upon our findings, ensuring a thorough and rigorous exploration of the fingerprinting of marble sources in the Cyclades.

The Significance of this Pilot Study for the Archaeology of Tinos

An island with a timeless tradition in the field of marble craftsmanship, Tinos seems to have been one of the key, albeit lesser-known, sources of Aegean marble in antiquity. Apart from the possible export of marble from Vathi to other areas outside Tinos, the question of the potential use of marble from the quarry on the island of Tinos is of particular interest.

The scope of the field of research concerning the use of local marble sources in the workshops of ancient Tinos highlights the number of relevant finds (sculptures, reliefs, inscriptions, *etc.*). Since their detailed presentation is beyond the purpose of this paper, we will only briefly mention the most important. In particular, the extensive use of marble as a building material is found in the buildings (temple, altar, fountain, *etc.*) of the great exurban sanctuary of the ancient city of Tinos, dedicated to the cult of Poseidon and Amphitrite in Kionia (4th century BC to 3rd century AD).[40]

Also noteworthy are the set of inscriptions, marble sculptures, and relief works from the sanctuary,[41] indisputable witnesses of the cultural prosperity of the island during the Hellenistic and Roman periods. The dolphins and seahorses from the sculptural decoration of the Doric temple of the sanctuary (3rd–2nd century BC) stand out among them, as do the marble orthostates from the altar with relief decorations, such as bucrania (bull's heads), flowers, fruits, *etc.* (2nd–1st century BC). Also significant are the statues of Emperor Claudius (1st century AD), which trace their origins to 'Building D', a temple specifically devoted to honouring the Roman imperial family of the Julio-Claudians.

The history of the sanctuary is closely linked to that of the ancient city of Tinos, *asty*, in the location of present-day Chora.[42] Known marble structural elements most probably come from the public buildings of the market of the ancient city ('*Prytaneion*', *palaestra*, theatre, *etc.*) in present-day Evangelistria. From a public building, probably the '*Prytaneion*', comes a series of important marble inscriptions informing us about the constitution of ancient Tinos.[43] Finally, however brief this exposition, the tombstones from the cemetery of Vardalakos in Xomburgo cannot be overlooked. Some of these, made of local marble, are excellent works of art which showcase the skill of the sculptors of Tinos in the Classical period (5th–4th century BC).[44]

A comprehensive future examination of these objects will play a crucial role in determining the potential utilisation of Vathi marble and, by extension, shed light on the broader spectrum of marble selection prevalent on the island of Tinos. Through meticulous analysis, we aim to unravel the historical, cultural, and functional implications embedded within these materials.

Conclusions and Future Approach

The Vathi quarry at Tinos comprises two quarry zones, one in the gneiss formation and the second in the white marble formation. It is not possible to determine

[40] Étienne, Braun 1986, 151–152.
[41] Queyrel 1986, 267–320.
[42] Étienne 1990, 15–30.
[43] Kontoleon 1953, 224–234.
[44] Kourou 2023.

Table 1: The analytical data of the Vathi quarry on Tinos, including stable isotope analysis ($^{13}C/^{12}C$ and $^{18}O/^{16}O$); ion-chromatography data for lithium, sodium, potassium, magnesium, calcium, fluorine, chlorine, bromine, iodine-jod, nitrate, sulphite ions in ratios, and DS (the amount of sodium, potassium, and chlorine in ppb in the extracted solution); and the ICP-MS analysis of magnesium, manganese, iron, strontium, chromium, vanadium, yttrium, cadmium, boron, lanthanum, cerium, praseodymium, dysprosium, holmium, ytterbium, lead, and uranium, in ppm (by V. Anevlavi and W. Prochaska; ÖAI/ÖAW).

lab no.	sample	Li	Na	K	Mg	Ca	F	Cl	Br	J (I)	NO_3	SO_4	DS	$\delta^{18}O$ (PDB)	$\delta^{13}C$ (PDB)
9008	Tinosvat1	0.1	279	193	373	10725	4	541	1.8	1.6	734.3	62.8	1013	-6.1	1.1
9009	Tinosvat2	0.1	443	372	133	11550	5	1049	2.3	1.6	1158.7	128.3	1863	-5.7	2.1
9010	Tinosvat3	0.1	1671	419	446	11792	18	4619	9.0	1.7	1285.0	821.4	6709	-9.1	0.9
9011	Tinosvat4	0.1	273	194	221	9668	6	514	1.5	2.0	1141.4	65.5	980	-5.5	1.7
9012	Tinosvat5	0.1	372	199	702	10661	6	934	2.1	3.2	996.3	98.3	1505	-5.7	2.0
9013	Tinosvat6	0.1	323	108	553	9197	3	743	1.6	2.0	509.9	90.3	1174	-5.9	1.6
9014	Tinosvat7	0.2	383	142	764	9630	13	724	2.2	2.7	689.2	171.4	1249	-6.9	1.8
9015	Tinosvat8	0.2	457	186	756	11335	9	736	2.5	4.0	720.6	1596.0	1379	-5.0	0.8
9016	Tinosvat9	0.3	734	122	1492	14199	6	1540	4.3	5.1	708.9	311.7	2395	-9.2	1.8
9017	Tinosvat10	0.2	413	287	1261	10060	15	1069	2.5	4.0	1383.1	170.0	1769	-6.4	2.1
9018	Tinosvat11	0.2	419	142	750	9936	3	833	2.8	2.4	721.6	174.1	1394	-5.4	1.6
9019	Tinosvat12	0.2	637	143	1278	13971	6	1504	2.9	3.5	678.8	239.0	2285	-8.6	1.7
9020	Tinosvat13	0.1	312	131	724	9667	5	1005	1.3	1.3	404.6	112.9	1449	-5.4	1.6
9021	Tinosvat14	0.3	295	236	n.a.	11744	8	675	1.5	1.0	553.7	103.9	1206	-6.1	1.4
9022	Tinosvat15	0.3	358	137	813	9216	3	702	1.7	2.2	408.6	161.3	1197	-7.7	1.8
9023	Tinosvat16	0.3	793	124	494	10578	5	2236	2.1	1.9	722.3	425.9	3154	-7.5	2.3
9024	Tinosvat17	0.1	3679	305	n.a.	10694	5	10604	12.5	1.1	1368.7	485.1	14588	-5.6	1.2

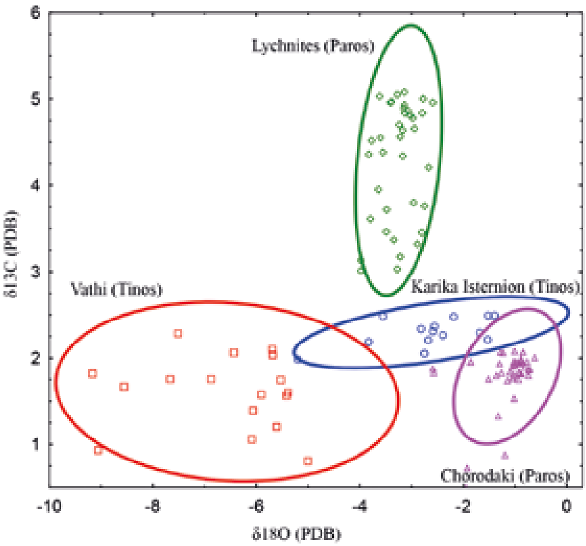

Fig. 7. The preliminary isotopic diagram of the Tinian and Parian sources (compiled by V. Anevlavi and W. Prochaska; ÖAI/ÖAW).

the chronology of either quarry, apart from their logical relative chronology, putting the gneiss quarry first and the white marble quarry second. However, the chronology of the white marble quarry can be made more precise because it fits below the zone of the gneiss formation, which was eliminated using mechanical drilling and explosives. Mechanical drilling was also used for the carving of the wedge holes in the white marble quarry. With these technologies, it is not possible to propose a chronology for the white marble quarry before the end of the 19th or during the 20th century.

Despite its relatively recent chronology, it seems clear that the technologies used for the extraction of the blocks were still close to those used in antiquity, *i.e.*, the use of a quarry pick for the cutting of vertical extraction trenches and the equally classical technology of combining wedge holes and iron wedges to break the blocks from the rock formation beneath. However, the carving technique for the wedge holes, first mechanically drilling a hole, followed by its enlargement with a pointed chisel,

Mg%	Mn	Fe	Sr	Cr	V	Y	Cd	B	La	Ce	Pr	Dy	Ho	Yb	Pb	U
0.45	88.07	146.12	136.95	1.427	0.140	1.407	0.493	2.588	0.335	0.261	0.045	0.076	0.022	0.069	0.284	0.006
0.03	10.73	61.91	122.53	1.391	0.054	1.242	0.175	2.988	0.515	0.468	0.076	0.089	0.022	0.067	0.248	0.013
0.35	208.58	244.33	268.96	1.445	0.097	0.974	0.195	5.987	0.430	0.452	0.072	0.074	0.020	0.061	2.107	0.006
0.26	31.29	346.11	141.67	1.493	0.123	2.750	0.144	2.324	1.228	0.783	0.201	0.209	0.050	0.132	0.292	0.006
0.94	84.41	156.72	154.57	1.444	0.130	2.210	0.202	2.230	0.962	0.929	0.138	0.146	0.035	0.089	0.364	0.008
0.83	71.67	139.86	150.48	1.555	0.122	2.527	0.198	2.484	0.607	0.407	0.082	0.138	0.038	0.115	0.510	0.005
1.44	140.98	361.87	147.80	1.533	0.159	2.278	0.234	2.055	0.823	0.309	0.112	0.146	0.041	0.108	0.336	0.006
0.51	141.11	165.59	163.59	1.543	0.195	1.151	0.154	2.353	0.473	0.326	0.059	0.065	0.017	0.060	0.195	0.014
2.92	151.79	329.45	240.32	1.481	0.157	2.692	0.315	2.651	0.767	0.637	0.119	0.160	0.042	0.126	1.681	0.004
1.55	97.71	216.21	135.34	1.526	0.170	4.069	0.241	2.610	1.215	0.491	0.141	0.198	0.058	0.188	0.337	0.008
0.87	70.24	121.06	143.70	1.508	0.118	1.506	0.213	2.146	0.520	0.185	0.089	0.114	0.028	0.068	0.171	0.006
0.71	57.94	164.02	166.80	1.459	0.105	1.870	0.206	3.055	0.643	0.471	0.093	0.115	0.031	0.080	1.425	0.007
0.83	74.55	222.36	153.71	1.553	0.156	1.462	0.193	3.938	0.560	0.249	0.069	0.094	0.025	0.070	0.376	0.009
0.21	86.43	160.15	147.79	1.451	0.072	1.218	0.167	1.811	0.982	1.247	0.162	0.103	0.024	0.067	0.356	0.006
1.81	96.80	220.32	139.32	1.491	0.160	1.598	0.163	2.695	0.847	0.291	0.141	0.126	0.030	0.081	0.741	0.004
0.46	22.93	93.04	143.11	1.540	0.079	1.794	0.287	3.510	0.545	0.230	0.076	0.125	0.034	0.090	0.430	0.007
0.62	157.45	276.77	133.65	1.503	0.113	0.722	0.276	1.728	0.427	0.265	0.062	0.062	0.014	0.042	0.238	0.007

is again a recent technology, apparently unique, and perhaps of local origin. The dates engraved on a door lintel of one of the quarry workers' houses (1858) and on the top of the white marble wall (1889) also point to the end of the 19^{th} century for the extraction of the white marble.

Moreover, the geochemical data not only provide a unique fingerprint for each location but also serve as a crucial element in our comparative examination. This study contributes significantly to analysing data from ancient quarries on Tinos, including Karika Isternion, Lychnaftia, and others. We aim to juxtapose these findings with quarries from the broader Cyclades region and the ancient world, fostering a comprehensive understanding of marble extraction, production, and use. In essence, this pilot study functions as a foundational exploration, offering a snapshot of isotopic variations among selected locations. Its timely presentation not only establishes the robustness of our research methodology but strategically positions us for a more extensive study, incorporating diverse sources from the Aegean. This staged approach is designed to progressively enhance our comprehension of the quarry, with each phase contributing to the cumulative depth of our research. Anticipated outcomes from the study of ancient quarries on Tinos include completing the information map of ancient quarries in the Aegean. Additionally, we expect to unveil new insights into the organisation of local quarries and workshops, both on Tinos and in the broader Cyclades. For provenance studies, a systematic sampling of ancient objects, such as sculptures and architectural elements, could potentially confirm the historical use of Vathi marble.

The exploitation of the stone landscape of Tinos is of special archaeological and historical interest. The current study of the Vathi quarry, in combination with the forthcoming studies of the marble quarry of Karika and the serpentinite quarry of Ras, will enlighten and enrich our information on stone quarries of the region. Therefore, Tinos provides valuable new insights into the understudied subject of ancient stone production and economy at a local and regional level. The exploitation of these sources could reveal information on the type of material and qualities used for a specific set of objects (*e.g.*, sculptures, sarcophagi, *etc.*), with parallel information on the tools, techniques and facilities, the motifs and styles, skills and knowledge, transportation, distribution, trade, and customers.

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Components as a Possible Enabler of 'Hobby' Crafters in the Mycenaean World[1]

Abstract

That crafting is undertaken by a range of individuals outside of economic necessity is a well-known feature of modern societies. These 'hobby crafters' have a diverse set of motivations, but the phenomenon as a whole has been strongly linked to the Industrial Revolution and associated emergence of distinct 'leisure time', in which craft hobbies can be pursued. Thus a narrative has been established that hobby crafting is a product of the modern era and, with few notable exceptions, little to no attention has been directed towards investigating whether such a mode of production was also present in premodern or even prehistoric communities.

As distinguishing between artefacts made by professional specialists and those produced by hobby crafters is by no means straightforward, this paper explores whether the practical and social conditions essential for hobby crafting could have been present in ancient communities. It demonstrates that, for such a mode of production to exist, intra-cross-craft communication between professional specialists and hobby crafters, materialised through components, is crucial. A particular form of jewellery from the Mycenaean Palatial-era Greek mainland (*c.* 1400–1200 BC) is used as a case study to illustrate how hobby crafting may have been present in an ancient society.

Keywords: intra-cross-craft, hobby craft, mode of production, Mycenaean, jewellery, craft

Introduction

Production and its organisation have always been important topics of investigation for archaeologists. Significant attention has been paid to identifying different modes of production, that is to say the various types of systems for coordinating and controlling artefact manufacture, as these have been considered an important marker of cultural complexity.[2] Each mode of production comprises a specific combination of individuals and their relations, locations for work, types of remuneration, distribution networks, forms of equipment, *etc.*, and has wider repercussions for associated factors such as scheduling, bureaucracy, learning frameworks, and gender and/or age-related roles, amongst others.

Most of this discussion has taken place against an assumed backdrop of economic need.[3] The potential existence of a mode of production purely related to social or personal need, within which crafters willingly produce artefacts without direct or indirect economic recompense,

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[2] Clark, Parry 1990, 309, 315, 321.

[3] Although archaeologists have recognised crafting's social benefits (*e.g.*, Brysbaert, Hochscheid 2021), discussion of prehistoric craft, including specialisation and skill, have centred on 'professional' individuals, *i.e.*, those who crafted to meet household needs or received some form of remuneration.

perhaps even incurring expense to do so, has been overlooked for premodern societies. This is despite its presence within our own societies: so-called 'hobby crafting'. Given that scholars have explicitly connected this modern phenomenon to societal changes wrought by the Industrial Revolution,[4] there has been an understandable unwillingness to explore the possibility in order to avoid projecting present-day values back onto the past. Although it is important to refrain from making simplistic links between past and present, it can be argued that assuming the presence or absence of a mode of production based on modern preconceptions is just as problematic.

Detailed consideration of this possibility is needed. However, the most basic analysis of modern hobby crafting reveals that it is as complex a mode of production as every other. Furthermore, and despite certain expectations (especially pertaining to skill), examination of contemporary artefacts demonstrates that there is no straightforward checklist of characteristics that can distinguish between the products of hobby crafters and those manufactured through other modes of production. Similar difficulties should be anticipated within premodern communities. Nevertheless, the surrounding framework that enables the emergence and persistence of hobby crafting can be analysed, and thus used to investigate whether the potential for a similar phenomenon existed in past, perhaps even prehistoric, communities.

Hobby Crafting as a Modern Mode of Production

A household survey conducted by the Association for Creative Industries (AFCI) in 2016 in the United States found that 64% of respondents had participated in some form of hobby crafting within the last year, which, along with other data from the same survey, led it to estimate that the US hobby crafting sector was worth approximately $44 billion.[5] Despite this, there has been a reluctance to seriously research hobby crafting until relatively recently.[6]

Investigating any mode of production requires developing an understanding of its enabling framework. On the one hand, there are practical considerations; a compatible *chaîne opératoire* (production sequence) is essential, along with other factors including logistics, technology, transportation, knowledge base, *etc*. Social considerations, though, are of equal importance, such as cultural traditions, structures of knowledge transfer, social demand, communities of practice, status-defined roles, *etc*.

The Social Framework for Modern Hobby Crafting

Beginning with the latter, modern hobby crafting is acknowledged as meeting several social needs. The act of making can be, in itself, pleasurable, particularly if the hobby crafter is able to experience 'flow', or full immersion.[7] This enjoyment is often deliberately enhanced through well-made high-quality tools and materials designed to provoke sensory stimulation.[8] Use of acquired skills is also pleasurable,[9] and the ability to exert some degree of control over one's own actions an essential element of the experience.[10] Through making, a sense of selfhood and ownership is developed; it fuels self-identification and deepens the feeling of belonging, especially within the space where crafting takes place.[11] This can be extended by the finished products, which can be used by hobby crafters to improve their immediate environment[12] or as gifts,[13] although it seems the intrinsic rewards of the activities themselves are judged to be higher than the extrinsic ones.[14] Hobby crafting can also appeal to those wishing to connect to the past or with like-minded individuals, through communities of practice, although neither are necessary prerequisites.[15]

Therefore, although the concept of 'work undertaken for pleasure' can be difficult to comprehend,[16] the

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[4] See Maines 2009, 11.

[5] https://craftindustryalliance.org/craft-industry-growing-in-dollars-scope/.

[6] Maines 2009, 127. The AFCI 2016 household survey remains the only comprehensive survey of its kind undertaken to date.

[7] Csikszentmihalyi 1975, 36.

[8] Maines 2009, 13. In the realm of knitting, for example, it is not unusual for a yarn brand to be available in at least 10 colours, sometimes more than 100, with rosewood needles marketed as an essential luxury.

[9] Csikszentmihalyi 1975, 14.

[10] Csikszentmihalyi 1975, 25.

[11] Brysbaert, Hochscheid 2021, 13, 15.

[12] Maines 2009, 12–13. Although Maines classifies hobby crafting as a 'hedonising technology', a technology that "privileges the pleasures of production over the value and/or significance of the product" (Maines 2009, 3), such activities can be pursued primarily for the end product, especially by those interested in customisation and/or acquiring objects suited to their idiosyncratic tastes.

[13] Maines 2009, 123–124.

[14] Csikszentmihalyi 1975, 14. This perception is affected by socio-economic factors, gender, and age (Csikszentmihalyi 1975, 20).

[15] Maines 2009, 122–123. The desire for validation through competitive forms of social interaction varies according to individuals and the type of activity undertaken (Csikszentmihalyi 1975, 16).

[16] Maines 2009, 9–10.

idea that modern hobby crafting, offering transcendence through a combination of novelty and challenge,[17] can lead to personal fulfilment and inner peace now commonly forms part of its marketing. Of the AFCI survey respondents, only 10% of those who crafted did so for less than five hours per week, and 40% spent more than 20 hours per week crafting, strongly indicating how valuable such individuals consider their hobby to be.

Most hobby crafts are archaising, by intentionally utilising techniques and skills which have been replaced by industrial processes. Although it could be assumed this would cause difficulties for knowledge transfer, such skill transmission is widely practised, through books, expert-led courses, and now the internet.[18] The formation of communities of practice[19] is often encouraged by smaller craft stores to build their customer base, with public groups (*e.g.*, educational institutions, craftivism) and private groups (*e.g.*, kinship-based, closed circle of friends/colleagues) being common.[20] These also enable skill transmission.

The same household survey assessed the demographic characteristics of American crafters. They tended to be younger than average, with men comprising 40% of the total. Nevertheless, certain crafts demonstrate strong gendered differentiation,[21] not necessarily matching its demographics prior to its adoption as a hobby.[22] In terms of social status, R. Maines has convincingly argued that the Industrial Revolution, rather than allowing hobby crafting to first emerge, in fact drove it to become increasingly democratised.[23] Therefore, it should be expected that socio-economic factors now play a smaller role in determining the likelihood of hobby craft engagement, although they do still impact other aspects. These may include the quantity and quality of materials, tools, and available time, as well as the opportunities for knowledge acquisition.

The Technical Framework for Modern Hobby Crafting: the Role of Components

For hobby crafting to take place, it must be technically feasible. Modern industrial nations have advanced communication networks that facilitate logistics and transportation, which the hobby craft market can tap into. The knowledge base for such crafts has been developed over many millennia, with current innovation being driven through communities of practice. Similarly, the required technology, in terms of materials and tools, is mature, and in many cases such essentials are shared with industrial processes. However, the *chaînes opératoires* for hobby crafting do demand special consideration, and fundamental to these is the incorporation of components.

A significant proportion of material culture is formed from components, defined in the Oxford English Dictionary as 'a constituent element or part'.[24] Components are a specific form of semi-product used in composite artefacts; common examples include handles, tool heads, hinges, *etc*. The majority are shaped to the required specification and assembled with little to no further modification. Their design often integrates features to facilitate assembly, such as sockets or rivet holes. In this respect they are distinct from other semi-products like ingots. Exceptions include components such as rivets, the modification of which during assembly is crucial to their functioning, and formless examples like glues, oils, and paints.

Components are necessary to produce artefacts composed of multiple materials, those with moving parts, or to achieve complex forms. Their use can permit greater and finer control over the *chaîne opératoire*. This confers other benefits such as increased scope for standardisation and efficiency, as well as the avoidance or mitigation of risky or complex procedures through simplification of the *chaîne opératoire*. In addition, components are sometimes favoured in market-based economies due to other factors less applicable to premodern societies, such as to smooth supply and/or demand curves.[25]

Although not essential to their usage, the integration of components into a *chaîne opératoire* can be exploited to enable multiple people to contribute. Modern factory production lines, for example, rely on a component-based strategy to bring to bear a greater quantity of

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[17] Csikszentmihalyi 1975, 30, 33. This is common to all activities initiated primarily for their own sake. Other scholars have also commented on how physical and mental challenges contribute to crafting pleasure (*e.g.*, Bamforth, Finlay 2008, 3).

[18] For example, the YouTube video "How to Crochet for Absolute Beginners: Part 1", uploaded by simplydaisy on March 16th 2015, had (on June 26th 2023) been viewed 30417606 times, was part of a channel with 432000 subscribers, and had attracted 13419 comments.

[19] Following the original definition, summarised as "relatively stable communities of face-to-face interaction between members working in close proximity to one another, in which identity formation through participation and the negotiation of meaning are central to learning and knowledge generation" (Amin, Roberts 2008, 355). Note that their conclusions on 'craft/task knowing' and its relationship to communities of practice are completely drawn from professional craft practitioners, and are not applicable to hobby crafting.

[20] See, for instance, Brysbaert, Hochscheid 2021.

[21] Maines 2009, 14.

[22] Brewing, previously a female household task and now a hobby pursued mainly by men, is a good example (Maines 2009, 85).

[23] Maines 2009, 31, 63–64, 126.

[24] Meaning no. 2a. https://www.oed.com/view/Entry/37759?redirectedFrom=component#eid.

[25] Ulrich, Ellinson 2005, 317–318, 322.

labour (both human- and machine-based) upon the manufacture of a single artefact, thus greatly decreasing production time. Components can open up new approaches to the division of labour that encourage deeper individual specialisation. This allows artefacts to become a focal point for actions carried out by different craftspeople with diverse background expertise. They also enable production to take place at more than one location.

Both hobby crafting and the 'do-it-yourself' (DIY) industry[26] take advantage of the capacity of components to concentrate or minimise complexity at different stages of the *chaîne opératoire*, allowing the end consumer to successfully complete activities with only a restricted skill-set, basic tools, and a selection of components. Thus, the end consumer possesses a specific set of skills geared towards the use of these components, rather than their production. The components themselves may be designed differently to those present in professional settings to support these changes. Especially for hobby crafting, elements of the *chaîne opératoire* can be cherry-picked to include only those considered the most rewarding or exclude those deemed too risky with regard to successful completion of an object.[27] As with DIY, for hobby crafting to be a successful mode of production it is the last stages of the *chaîne opératoire* that must be suitable for the involvement of hobby crafters. This may entail changes to the *chaîne opératoire* that simplifies or removes the need for specialist equipment during the final stages, but which can also make it less efficient, demand different components, or otherwise appear illogical within a professional setting. Certain objects are, therefore, inherently less suitable for hobby crafting as their final stages comprise tasks such as electroplating.[28] Community-based resources, like specialist institutions offering their equipment or expertise to the general public, can help circumvent this difficulty; generally such arrangements are contingent on cultural factors and traditions.[29]

The entry requirements for both DIY and hobby crafting activities can be lowered through the provision of kits.[30] Although varying in completeness, their purpose is to provide all the specialist components, tools, and know-how, leaving the end consumer only needing to provide skill and some basic components, tools, and/or labour. Certain stages of the *chaîne opératoire* are significantly simplified, such as sourcing the necessary materials, whilst others are completely outsourced to specialist crafting units, such as design. The potential for certain other difficulties is also reduced. For instance, one of the most time-consuming aspects of craft production is learning how to deal with unexpected problems,[31] but kits effectively outsource this by testing the entire *chaîne opératoire* beforehand. Craft kit designers often indicate the required skill level, allowing the end consumer to roughly match their ability against the range on offer. Thus, although kits can be used to lower skill requirements, they also enable hobby crafters to employ much more advanced techniques than possible without this support, specifically allowing them to concentrate on developing their practical crafting abilities.

An excellent modern example are the component crafting kits produced by the beading company Spellbound, established by Julie Ashford in 1984 (Fig. 1). End consumers use these kits to create complex three-dimensional ornaments and trinkets using little more than beads and thread. The exact path taken by the needle through the beads determines their position, and even minor path adjustments lead to radically different outcomes. The design process is therefore complex, encompassing the concept, aesthetic appearance, and pre-determining the required needle pathway, and relies upon specialist knowledge of stitches and techniques unique to beading. Manufacture is comparatively easier, requiring both less skill and knowledge. Spellbound's kits thus enable hobby crafters to create complicated objects well beyond their own design capabilities, whilst employing beading techniques appropriate to their current skill level and learning ambitions.

One significant drawback to kits is that they can limit opportunities for personalisation and innovation. Effectively, total control over design is traded for the ability to create something beyond an individual's personal capacity. The use of kits for craft production has been perceived by scholars as a negative development inextricably bound to modern consumerism; artefacts produced this way are regarded as inherently inferior because they lack 'authenticity' or 'artistic value'.[32] In fact, companies such as Spellbound are highly innovative, and additionally

[26] Their end consumers are sometimes labelled 'prosumers'.

[27] In the latter regard it is similar to 'scaffolding', the process of integrating novice apprentices into craft production by giving them basic risk-free tasks (Ferguson 2008, 52).

[28] Such processes do, of course, take place outside modern factory settings, but the individuals involved are often professional or semi-professional artisans who have invested in suitable facilities and use their craft as an income stream.

[29] Art colleges, for instance, may offer space in their ceramic-firing kilns to local hobby crafters and/or artisans, whose circumstances may prevent them from installing or running their own.

[30] Categorised by Atkinson (2006, 3) as 'reactive' DIY.

[31] Bamforth, Hicks 2008, 152.

[32] Hackney 2013, 173; Richmond 2020, 551. Csikszentmihalyi (1975, 141) emphasised that 'micro-flow', induced by activities requiring lower skill, was still of great personal importance to participants.

Fig. 1. A – contents of Spellbound beading kit, with basic tools lined up across the top; B – sample beading project in various stages of completion (photo by S. Aulsebrook).

offer components for hobby crafters who are interested in personal design and customisation. Not only has their potential as a gateway to building confidence prior to individual experimentation been widely ignored, the possible existence of modes of production based on kits in past communities has been completely overlooked, to an even greater extent than hobby crafting more generally.

Hobby crafting is, therefore, fundamentally intra-cross-craft. It involves the interaction of at least two modes of production to create a single artefact, but sometimes three: industrial premises producing mass-market components; small-scale businesses designing patterns, creating kits, and/or producing specialist components;[33] and the end consumer, who assembles the final product. Along the *chaîne opératoire*, important linkages are made between hobby crafters, professional experts, and component suppliers, which incorporate the exchange of knowledge as well as providing the framework for production. At the broader scale, that process today is predominantly driven by market forces but also by craft shows, where producers of hobby craft components, designs, and kits meet face-to-face with their end consumers, creating forums for direct feedback and opportunities for skill and knowledge transmission.

Hobby Crafting as a Premodern Mode of Production

After establishing an understanding of the social and technological conditions that facilitate modern hobby crafting, it is now time to turn to the past and consider whether such conditions were also present. Before doing so, it is necessary to acknowledge that, for the majority of the 20th century, the general scholarly consensus was that hobby crafting emerged as a result of the Industrial Revolution. The reduced number of hours spent in an external workplace, coupled with what was considered the uniquely alienating conditions of modern work, were

[33] There are small-scale suppliers, for instance, who hand-spin and dye high-quality animal fibres from their own livestock; their yarn sells for premium prices.

seen as the essential factors that created hobby crafting, characterised either as an alternative 'opium of the masses' or the manifestation of an unconscious desire to rebel against modern life.[34]

In fact, the derivation of pleasure from hobby crafting is directly documented from the late 17th century AD onwards,[35] and R. Maines has gathered together compelling indirect evidence from historical records that pushes this back further, at least into the medieval era.[36] Indeed, her analysis of medieval female needleworkers finds many overlaps with modern hobby crafting: the use of luxury materials and tools, the commissioning of top artists to supply designs and/or use of images in other media for inspiration, the development of communities of practice sustained internationally through the exchange of samplers[37] as well as in-person group settings, and the gifting of finished items to institutions, such as the church, or as bequests.[38] Although skill levels would have varied, there is no doubt that some of the highest-quality extant textiles from this period were made by skilled noblewomen.[39]

The most fundamental difference to modern hobby crafting is the social status of its participants. These women belonged to the highest echelons of society, as members of the aristocracy and royalty. The Industrial Revolution democratised hobby crafting,[40] with the accompanying development of standardised kits for retail dependent on the newly formed mass market. It is, therefore, more likely that the majority of hobby crafting before the Industrial Revolution was practised by high-status individuals, and that the provision and appearance of kits, if present, was far less standardised.

Within millennia-long trajectories of social stratification, even in prehistory it is possible to identify specific groups of individuals with a privileged position within social hierarchies who, through institutionally sanctioned claims on resources and the labour of others, had time available beyond that required to meet their immediate subsistence needs (food, water, shelter, clothing, *etc*.). Some of this time would have been absorbed meeting culturally determined subsistence needs, which probably varied according to social identity markers, such as age, status, or gender. These could include commodities that are frequently referred to in the archaeological literature as luxuries, such as perfume, wine, or chariots, but which within the prevailing cultural framework were necessary to maintain social position.

Nevertheless, it is clear that, from at least the Upper Palaeolithic onwards, time was available to partake in activities not strictly bound to meeting immediate subsistence needs.[41] It is important not to confuse this 'beyond subsistence time' with our own modern 'leisure time'.[42] Control over its use was not necessarily in the hands of individuals. The activities undertaken during this 'beyond subsistence time' were probably closely tied to social obligations and ideas of correct behaviour, and linked to social identity markers, like those mentioned above. Emically, that is to say from the internal cultural viewpoint, they may have been described as traditional, fitting, or even virtuous.[43] Attending feasts or participating in ritual ceremonies, for instance, may or may not have in themselves been enjoyable activities, but involvement was unlikely to have been directed solely by individual choice.

Taking into account all of the above means that the quantity of this 'beyond subsistence time' cannot be easily calculated. Nor is this necessarily a logical way to characterise time in ancient communities, which perceived time as task-orientated.[44] However, the increase in social inequality that enabled higher-status individuals to

[34] See discussion in Maines 2009, 11–12, 127 and associated list of references. Whilst an overt desire for non-conformity may form the clearly expressed primary reason for certain individuals (see, *e.g.*, Hackney 2013, 170), the so-called 'radical' nature of hobby crafting is exceptionally complex (and should not be reduced to either of those caricatures), which is why it is possible to celebrate its potential for activism whilst simultaneously acknowledging its staid image within the very same article (Hackney 2013).

[35] Maines 2009, 40. See Beck 2002, 40, fig. at bottom, for a contemporary illustration of noblewomen enjoying needlecraft in a high-status surrounding.

[36] See Maines 2009, 22–24 and associated list of references.

[37] Over time, samplers developed into a rite of passage for young girls, becoming formulaic. Originally, samplers were used to test and transmit stitch types; for examples see https://collections.vam.ac.uk/search/?q=sampler&page=1&page_size=50&year_made_from=1000&year_made_to=1700.

[38] Maines 2009, 19–27, 29–31.

[39] See, for example, an embroidery by Mary, Queen of Scots on display at the Palace of Holyroodhouse, https://www.rct.uk/collection/28224/embroidered-panel.

[40] Maines 2009, 20.

[41] Jewellery, made from bone, stone, mammoth ivory, and shell, was already an established element of material culture assemblages from at least the Initial Upper Palaeolithic onwards (see, *e.g.*, Shunkov *et al.* 2020). Whether this represents the very first instance of hobby crafting is a debate for another paper.

[42] An alternative could be 'free time' but, due to the potential double meaning of the word 'free', the intended connotation that it is time devoid of the need to perform other tasks could be confused with the idea that it is time free to be used according to individual choice. Therefore, this paper will continue to use the more descriptive term 'beyond subsistence time'.

[43] Maines 2009, 34. Maines (2009, 14) notes that the ability to take pleasure is affected by societal acceptance.

[44] Damm 2000, 113.

acquire 'beyond subsistence time' also provided a mechanism through which it could be denied to others, perhaps through slavery or other forms of extreme institutionalised inequality. Thus, the right to 'beyond subsistence time' would have become, in itself, a marker of social status, regardless of actual quantity, and, moreover, could be used to develop different types of personhood exclusively associated with elites. The exact nature of this high-status personhood would have depended upon the socially approved activities used to fill this 'beyond subsistence time', including access to self-improvement activities (*e.g.* education, physical training), entertainment (*e.g.* music, dance, recitations), volunteering (*e.g.* for charities, mentoring), or hobby crafting. Fundamentally, within the specific cultural context, all these could have been perceived as contributing to the production of superior individuals: more learned, more fit, more cultured, more moral, and more skilled. Such potent class distinctions would have lent themselves easily to 'othering' and, therefore, not only marked but created social status. Activities such as hunting or hobby crafting could reinforce these hierarchies directly, by forcing lower-status household members to execute more menial, less pleasurable but necessary tasks, as occurred in Medieval Europe.[45]

Evidence of participation was thus important. Certain activities, such as hunting or dancing, happened in groups, creating exclusive communities of practice. For long-term commitments, such as physical training or education, proof lay in the ability to demonstrate the acquired capabilities to others. For hobby crafting, the artefacts themselves constituted evidence, both in terms of their very existence and their embodiment of acquired skill.

Currently, there is no space within mainstream archaeological theory for hobby crafters, especially highly skilled hobby crafters. The basic premise that high skill is invariably linked to economic specialisation has meant that crafting for any other reason than economic necessity is absent from standard typologies.[46] Indeed, M. Kuijpers has directly linked skill with professionalism, by categorising craftspeople associated with low-skill products as 'amateur'.[47]

It has thus been necessary to start from scratch. This exploration of modern hobby crafting, coupled with R. Maines' analysis of elite medieval female needleworkers, has provided the basis upon which the following criteria have been identified as potential markers for the involvement of past elite individuals in the hobby crafting of particular forms of artefacts:

1) the practical potential, facilitated through components, to meaningfully contribute to the final production stages of certain objects which were already economically accessible;

2) the use of high-status materials, especially during the stages identified as suitable for hobby crafting, comparable to those that constituted their day-to-day material environment;

3) the possible existence of a shared community of elite peers within which crafting knowledge and know-how could be communicated;

4) the potential to create objects with distinctive biographies that made them suitable for gift exchange, heirlooms, and use within socially important settings.

It is now time to put these ideas into action and test them against an archaeological case study.

Gilding and Assembling Mycenaean Glass Jewellery – a Potential Hobby Craft?

Metal foil production technology was present in the Aegean from the Early Bronze Age (third millennium BC) onwards, and metal foils were already used during this period not only to make objects but also to cover other materials, for example through gilding.[48] Metal foil usage continued into the second millennium BC,[49] and within the Mycenaean culture, which developed on the Greek mainland, their exploitation expanded significantly, involving both a wider range of materials and new classes of objects.

One of those novel materials was glass. Appearing in the Aegean from the end of the Middle Bronze Age, its primary use in this region was for small jewellery components, particularly individual beads, plaques, and more complex three-dimensional ornaments, with Aegean-specific designs that followed traditional forms already produced in gold, as well as for seals, which again followed traditional Aegean forms produced in other materials.[50] These glass jewellery components were incorporated into larger composite objects for use, such as necklaces, bracelets, and even diadems[51] (Fig. 2). However, the Aegean itself did not manufacture glass, and it had to be imported

[45] Maines 2009, 26–27.

[46] Such as Clark, Parry 1990. The absence of hobby crafting may be justifiable in terms of its importance and impact on past societies, as well as its archaeological visibility. However, regarding these typologies as fully comprehensive could be potentially misleading.

[47] Kuijpers 2018, 561. This, again, may be fully justifiable in terms of the overall assessment of production in a society, but has the unfortunate side effect of discouraging investigation into high-skill hobby crafting.

[48] For examples see E. Davis 1977, 95; Hickman 2012, 525.

[49] E. Davis 1977, 96–97.

[50] Nightingale 2008, 68; Eder 2015, 233. Most glass seals had a stringing hole, and should also be classed as potential jewellery components.

[51] Yalouris 1968.

Fig. 2. The 'Mykenaia' fresco, from the Cult Centre at Mycenae, depicts a woman bedecked in necklaces and bracelets of different hues. Elite men also wore jewellery during this period (photo by M. Łapińska/ P. Jurkowska).

as raw material ingots from glass production centres based elsewhere in the Eastern Mediterranean.[52] Archaeological evidence for this trading activity has been found on the Ulu Burun shipwreck: its cargo included an estimated 350 kg of glass ingots.[53]

During the Mycenaean Palatial Period (*c.* 1400–1200 BC),[54] mould-based 'mass production' of small glass jewellery components and seals was developed;[55] such moulds have been recovered from multiple sites[56] (Fig. 3), and the glass jewellery components produced in this way became widely distributed.[57] Gilded versions of these glass jewellery components are not an uncommon find in Mycenaean contexts (Fig. 3), generally funerary, with the gold usually completely covering at least one face. Less frequent were glass relief ornaments inlaid with gold foil (partial gilding), some of which also had holes to enable the insertion of gold wires to hang miniature gold foil and glass circles for additional decoration.[58]

Bronze Age Aegean scholars have tended to approach the gilding of all materials, including glass, predominantly from a socio-economic perspective, considering its primary motivation to have been a cost-effective use of a scarce resource.[59] This 'scarcity', however, was to a great extent artificial: a continuation of a widespread long-term socio-political trend to ensure that gold was primarily concentrated in the hands of a few, who employed it liberally.[60]

The gold jewellery component prototypes, upon which the glass versions were based, were hollow rather than solid and, therefore, did not incorporate significantly more gold than their gilded glass equivalents,[61] even though their overall visual effect was similar (Fig. 3). The latter, though, were far easier to produce and, perhaps more importantly, amenable to 'mass production' through the technique of moulding, as mentioned above. For instance, granulation, one of the most complex, intricate,

[52] Shortland 2016, 101.
[53] Pulak 2010, 867.
[54] Manning 2010, tab. 2.2.
[55] Müller 2012, 465. Moulds were also used for producing gold jewellery components, but were not necessary for the gilding of glass jewellery components (see discussion below).
[56] Tournavitou 1997, 213; Boulotis 2005.
[57] Eder 2015, 233.
[58] For an example, see Xenaki-Sakellariou 1985, 138 Γ 2293(3) pl. 39α, β.
[59] See, *e.g.*, Vermeule 1975, 29; E. Davis 1977, 95–98; Sherratt 2008, 218; Müller 2012, 466; Kaparou, Oikonomou 2022, 2.
[60] Schoenberger 2011. This may have been reinforced, for example, through sumptuary laws: see Aulsebrook 2020, 254–255.
[61] The difference is measured in fractions of a gram per ornament; only at scale would this have become apparent. It is worth reflecting that the efficient use of luxury materials may not have been a primary concern during production, especially considering that jewellery is often associated with conspicuous consumption.

Fig. 3. A – damaged gilded glass double argonaut bead, revealing the glass substrate below (photo by: M. Łapińska/P. Jurkowska); B – comparison of granulated hollow gold bead (left) against two gilded glass beads with faux granulation (right) (photo by M. Łapińska/P. Jurkowska); C – Mycenaean jewellery mould (photo by S. Aulsebrook).

and time-consuming goldworking techniques known to Mycenaean craftspeople,[62] was frequently used to decorate gold jewellery components. Yet its visual and haptic impact was replicable in glass with only a little additional carving of the initial mould. This meant that 'faux-granulated' glass jewellery components were effectively as easy to make as those without this form of decoration, once the mould had been appropriately modified. It is, therefore, more plausible that the gilding of glass jewellery components was not intended as a cost-effective use of a scarce resource, namely gold, but rather to allow the production output of gold-based jewellery components to be increased, just as moulding had achieved for glass-based jewellery.

Generally, since scarcity (real or artificial) is linked to perceived worth, a substantial increase in the production output of a particular object would be expected to correlate with a decrease in its individual value. Nevertheless, it is clear that, despite the introduction of moulding, glass retained its high social and economic value,[63] as demonstrated by the burial assemblages which prove that gold, glass, and both completely and partially gilded glass jewellery components were combined together, alongside versions made from precious stones like carnelian and amethyst.[64] The increased production output of both glass- and gold-based jewellery components was thus mainly absorbed by members of the highest echelons of Mycenaean palatial societies, and should not be interpreted as indicative of substantially widened access to this form of jewellery by a broader range of status groups.[65] Rather than challenging or undermining Mycenaean elite identity, moulding and gilding glass jewellery were apparently quickly accepted and rapidly assimilated into it. The increased production output was not seen as a threat, but instead actively encouraged.

Given that control over this industry was exercised by the ruling classes themselves, what could have motivated this increased elite-driven demand? From both iconography (Fig. 2)[66] and tomb assemblages,[67] it is evident that

[62] Konstantinidi-Syvridi *et al.* 2019.
[63] Hughes-Brock 2011.
[64] Nightingale 2008, 68.
[65] Although the distribution of glass objects within the cemeteries at certain sites, such as Thebes, show that this material did reach beyond the upper echelons of Mycenaean societies, the same is true for other high-status materials, like gold, and the more restricted range and quantity supports the interpretation of the imposition of sumptuary regulations (Dakouri-Hild 2012, 476).
[66] Other examples include the well-known 'Procession of Women' from Thebes (for close-up colour images of the latest reconstructions, which show the jewellery in excellent detail, see Aravantinos *et al.* 2018, figs 6–8) and recently published wall-painting fragments, also from Thebes, depicting three female figures wearing multiple bracelets on their forearms (Kountouri 2018, fig. 1).
[67] For example, jewellery components numbering in the hundreds excavated together as a cluster were found in Chamber Tombs 2, 11, and 91 at Mycenae (Xenaki-Sakellariou 1985, 54–57, 71–73, 254–262).

these Palatial-era jewellery components were intended to be used *en masse*, with multiple finished objects, such as necklaces and bracelets, being worn simultaneously, each made of tens or sometimes hundreds of components. This, though, was a continuation of trends already in evidence at the beginning of the Mycenaean era,[68] and cannot by itself explain the increased demand during the Palatial Period. However, with the formalisation of the social hierarchy that accompanied the emergence of the Mycenaean palatial system, perhaps the number of people who required these jewellery components, which would have acted as markers of social status and insignia, rapidly increased.[69] The frequency and variety of events at which such objects were worn may have grown as well,[70] the latter in particular perhaps necessitating the ownership of a broader range of jewellery types. It has also been suggested that the palatial authorities themselves sought to reinforce their dominant position in Mycenaean societies by direct production of objects, such as glass jewellery components, that visually materialised relations of dependence between palatial and non-palatial elites.[71] Is it conceivable that another social factor, hobby crafting, also had a role in this increased demand?

There is no question that the production of glass jewellery components must have taken place in specialist workshops. However, to manufacture finished objects incorporating gilded glass jewellery components, the production of the glass components themselves is only one stage in the overall *chaîne opératoire*, as can be seen in the simplified model presented in Fig. 4. Analysing this breakdown of the production process through an intra-cross-craft perspective reveals a number of reasons why its two final stages, namely gilding and assembly, were potentially suitable and desirable candidates for elite hobby crafting.

First, these finishing stages were less complex and risky than the majority of the other stages of the *chaîne opératoire*, which instead required specialist knowledge and equipment, a suitable workshop facility, skilled manipulation of tools, high physical activity, and included the potential for personal injury, especially for those unfamiliar with handling the materials and tools. In contrast, the gilding of glass jewellery components and their assembly into finished objects required:

- *knowledge and skill*: the necessary know-how comprised a limited series of simple gestures easily achievable even by a novice and transmissible through observation alone. These tasks' inherent repetition would improve hand-eye coordination, leading to increased speed and quality without extensive training or practice. Some glass jewellery components were gilded on just one side, which would have significantly reduced the skill requirement.[72]
- *equipment (materials)*: all essential materials could have been supplied as ready-to-use components (gold foil, glass components, other finished jewellery components, technical textile (thread, cord)/wire).[73] They required minimal further manipulation and would have been identical to the components already used by professional specialists working in the palatial workshops; the foil and/or cord/wire may have been supplied pre-cut to size (effectively presented as a kit).
- *equipment (tools)*: gilding required a miniature cutting tool and small tools of soft material, such as bone or wood, with smooth blunt ends to push the foil against the substrate.[74] Assembly can additionally

[68] Large-scale assemblages of jewellery components from the dawn of the Mycenaean era are known from tombs such as Tholos A at Kakovatos, which contained almost 600 amber beads arranged into three large collars, as well as numerous beads of gold, amethyst, and lapis lazuli (de Vreé 2021, 96–97, especially fig. 3).

[69] For an overview of the various formal offices attested in the Mycenaean Linear B documents, see Shelmerdine 2008, 128–139.

[70] The Mycenaean Linear B archives mention specific named festivals, such as the 'festival of the new wine', which appear to have been formal occasions at which offerings were made and provisions supplied by the palatial authorities, as part of a strategy of legitimisation (Lupack 2011, 208, 211).

[71] Bennet 2008, 151.

[72] The material saving amounted to a few milligrams and, therefore, similar to the difference between gilded and hollow gold jewellery components discussed above, is unlikely to have provided the primary motivation.

[73] Metal foils are known from outside workshop contexts (Konstantinidi 2001, 236). Specialised clasps were sometimes used for necklaces (J. Davis, Stocker 2018, 621), but many jewellery components originally deposited as complete pieces, such as necklaces, lack evidence for their fastening; it is possible the cord was simply knotted. Little is known about Mycenaean goldworking adhesives (Konstantinidi-Syvridi *et al.* 2019, 45), but they are not necessary for gilding (see Papadimitriou *et al.* 2016). Analysis of other media has revealed organic binding agents including egg and vegetable gums (Brecoulaki *et al.* 2012, 2873). These are simple to prepare and were probably already present in elite households for other domestic tasks.

[74] Konstantinidi-Syvridi *et al.* 2019. If necessary, also an adhesive applicator, which would most probably have been rather similar in appearance and material. A mould was not required, as the gold foil would be stretched over and shaped directly onto the glass jewellery component itself (see Papadimitriou *et al.* 2016 for this technique). The foil used for gilding, although not as fragile as modern gold leaf, was thinner and more delicate than the thicker metal plate used for hollow gold jewellery components shaped in stone moulds. The use of the latter to 'pre-shape' the gold foil beforehand would have introduced a wholly unnecessary and highly risky step with limited practical benefit, given that the glass jewellery component would have contracted when cool, and the exact shape of each varied slightly due to inconsistencies during the moulding and post-moulding processes.

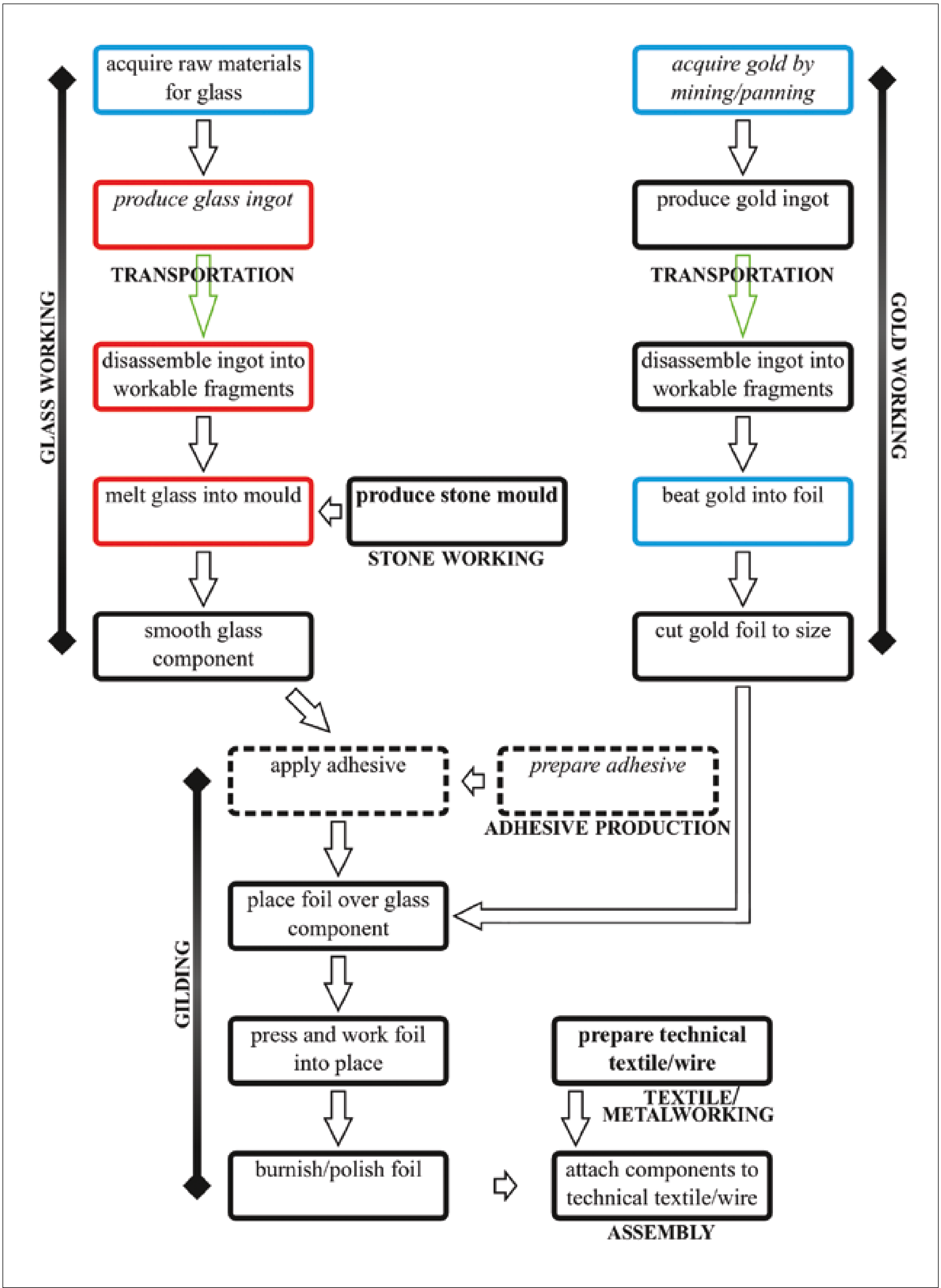

Fig. 4. Direct *chaîne opératoire* for the production of Mycenaean objects that incorporated gilded glass jewellery components. Risky tasks are highlighted in red, physically strenuous tasks in blue. Tasks requiring specialist knowledge are in italics, tasks requiring specialist skill in bold. Optional tasks are marked by broken lines (diagram by S. Aulsebrook).

require a needle. These tools are all of simple design, and suitable candidates were probably already present in elite households for other domestic tasks. Versions made from high-status materials may have enhanced the experience.[75]

- *equipment (facilities)*: the majority of these two processes can take place within the hands; components and equipment could have been stored on a flat surface or held by another household member.[76] Good lighting was essential, and readily available in Mycenaean elite residences. Therefore, a dedicated workshop facility was not required for either of these two stages.
- *physical activity*: both are delicate, quiet, repetitive, and absorbing tasks, needing only moderate concentration that would decrease with proficiency, allowing attention to be simultaneously directed towards other non-manual activities, such as conversation.
- *personal risk*: if used, adhesive could potentially cause mess; however, this stage is relatively quick and performed only once per item. This task was suitable for delegation to a lower-status household member. Cutting of the foil and technical textile/wire (if not provided as a pre-cut kit) would not have involved strenuous effort and, therefore, the risk of harm was low.
- *outcome risk*: gilding responds well to increased investment of time and patience, as it can be steadily reworked using successively finer and softer tools to improve its visual appearance. Minor tears could have been repaired by more skilled practitioners. Only a single jewellery component was ever 'at risk' at any one time, minimising the impact of mistakes. Problems that may have been encountered during assembly (*e.g.*, damaging components by dropping them) were comparable to those associated with the handling of the finished objects.

Every practical aspect of these two stages, gilding and assembly, was therefore compatible with the involvement of elite hobby crafters.

Secondly, there is a good fit between gilding and assembling Mycenaean glass jewellery components and the criteria for elite hobby craft involvement listed above. Glass and gold were highly valued imports with attractive visual and haptic qualities. Both tasks are amenable to collaboration, suitable within social settings, and can be easily learnt through observation and communication of discursive knowledge. Elite Mycenaean households were economically able to access comparable objects, like hollow gold and precious stone jewellery components (Fig. 2). The range of available jewellery component types meant that the completed pieces were highly customisable, imbuing individualised personal effort that could provide a suitable foundation for distinctive object biographies. Jewellery is a highly intimate possession eminently suitable for gift exchange and curation for future generations as heirlooms. The appearance of gilded glass jewellery in Mycenaean graves demonstrates it was considered appropriate for socially and emotionally charged actions. It must also be acknowledged that both gilding and the assembly of jewellery are activities pursued by modern hobby crafters, demonstrating that neither task is so complex that they should be regarded as suitable for professionals only.

Thirdly, detailed microscopic analysis of gilded glass jewellery components has shown that a range of quality outcomes was tolerated.[77] Folds, puckering, gaps between the foil and glass, and other minor flaws, created during the production process and not resulting from post-depositional damage,[78] are clearly evident on a small proportion of examples (Fig. 5). These would have been rather visible due to the way such flaws distort the reflectivity of the gold. Nevertheless, these poorly gilded glass jewellery components were not excluded from burial assemblages. One possible explanation for this was that the identity of the person who gilded those particular glass components was considered more meaningful than the visual appearance of the gilding itself.

Finally, the assembly of jewellery components into composite objects is likely to have occurred multiple times. Breakage[79] and sagging of the cord/wire must have been common, especially for heavier necklaces. Within the overarching framework of acceptable cultural practice, which was of especial relevance as these jewellery pieces would have played an important role in communicating aspects of status and social identity, their composite nature would have also provided opportunities for integrating newly acquired components, updating older pieces to fit changing tastes, and experimentation with decorative schemes. It is notable that, although based upon a limited repertoire of jewellery components that demonstrate substantial uniformity in terms of form, decorative motifs, and size,[80] the precise selection of

[75] Suitable ivory tools are known from Mycenaean contexts, *e.g.*, Konstantinidi-Syvridi *et al.* 2020, fig. 6.2.

[76] Tools and components in unexpected contexts should, therefore, be considered potentially indicative of hobby crafting.

[77] Aulsebrook forthcoming.

[78] The criteria for making this assessment will be presented in detail in the forthcoming paper. The presence of such flaws has also been identified by other scholars, *e.g.*, Xenaki-Sakellariou 1985, 267, Γ 4547(1–3), pl. 132, ANM 4547.

[79] J. Davis, Stocker 2018, 616.

[80] See the catalogue of forms presented in Xenaki-Sakellariou 1985.

Fig. 5. Four poorly gilded Mycenaean glass jewellery components with ivy-leaf decoration. Because the gold foil was not thoroughly pressed into the contours of the underlying design, the details have only been partially and vaguely transferred onto the foil (it is not possible for such traces to be erased by post-depositional damage), and consequently the foil itself has peeled away from the bead; excess folds are also visible (photo by M. Łapińska/P. Jurkowska).

jewellery components varies significantly between burial assemblages during the Mycenaean Palatial Period, including by quantity and material, as well as the three characteristics listed already.[81] Their use as status markers or insignia, therefore, did not rely upon consistent repetition of pre-determined sets. This would have provided an opening for individualisation, design collaboration, and the exchange of individual components as well as finished pieces. Moreover, the acknowledged physical and conceptual proximity between specialist workshops for jewellery components and the elite palatial authorities[82] should be considered, from an intra-cross-craft perspective, as providing the necessary linkage to potentially foster the development of hobby crafting. At the very least, design input from the patrons of these workshops cannot be precluded, and may help explain the curious conservatism observable in the moulded glass industry.[83]

Discussion

It is unlikely that hobby crafting could ever be proven to exist from archaeological evidence alone as, even though certain signs, such as variability in the quality of gilding, could indicate such a possibility, they can also be interpreted in alternative ways, such as the involvement of apprentices, or the need to meet time constraints. As noted during the discussion of modern hobby crafting, for certain categories of objects there are no reasons why those made by professional specialists and those made by highly skilled hobby crafters should not look alike. Furthermore, iconographic evidence to support this hypothesis is unlikely to be recovered. Certain other high-status 'beyond subsistence time' activities, like hunting,[84] are shown, and the archaeological remains of socially stratified feasting events have been uncovered.[85] However, Mycenaean iconography, although clearly geared towards the concerns of the elite, depicted only a limited repertoire of subjects, and no examples of production scenes are known.

Nevertheless, the gilding and assembly of Mycenaean Palatial-era glass jewellery components have provided an opportunity to examine how the distinctive characteristics of hobby crafting may be visible in the archaeological record. These processes meet the four criteria that form the enabling framework for elite hobby crafting as identified in the first half of this paper: 1) glass jewellery

[81] This also applies at the same site and even within the same cemetery; compare, for instance, the jewellery components from Chamber Tombs 93, 94, and 95 in the Asprochoma/Agriosykia cemetery at Mycenae, which differ considerably by form and proportion of materials present (Xenaki-Sakellariou 1985, 267–273).

[82] Bennet 2008.

[83] Kaparou, Oikonomou 2022, 2. Significant innovation may have also threatened the hypothesised involvement of hobby crafters.

[84] Immerwahr 1989, 129–133.

[85] Bendall 2004.

was strongly associated with elite individuals during the Mycenaean Palatial Period, and the two finishing stages of gilding and assembly were both practically suitable for hobby crafting; 2) high-status materials were used, particularly gold and glass, which was, at the time, an exotic import; 3) textual and iconographical evidence point to the existence of elite social gatherings, which would provide the potential to develop shared crafting communities, and the techniques themselves were highly transmissible; 4) the infusion of personal effort through gilding and combining jewellery components into individualised objects that acted as Aegean-specific cultural identity markers would have made it possible to build distinctive biographies for these jewellery pieces, which were used for socially significant actions (status signalling, funerary gifts, *etc*.).

Therefore, the apparently quick acceptance and rapid assimilation of moulded glass jewellery components into Mycenaean elite identity may have, at least in part, been stimulated by their potential to contribute to the process of forming and maintaining elite identity during the Palatial Period through their integration into elite hobby crafting. This does not mean that professional specialists based in palatial workshops would not have also continued to gild and assemble jewellery components; as in the modern world, even if this form of hobby crafting did occur, it would have accounted for only a small proportion of the total production output. Moreover, although jewellery has formed the focal point for this discussion, this does not, of course, preclude active elite participation in other craft activities within the Mycenaean world or beyond.

However, the purpose of this paper is not to prove beyond doubt that certain elements of Mycenaean Palatial-era jewellery production were elite hobby crafts – an all but impossible task – but to raise awareness of this mode of production as a viable prospect within past societies. Indeed, the consideration of hobby crafting in such societies should complement, not undermine, existing models of craft production. It has been argued that craft practice is, and always will be, a necessary marker of the human condition.[86] Yet, the unwillingness to examine craft beyond economic necessity, due to preconceptions about the Industrial Revolution and its re-framing of relations between producers and consumers, has effectively led to interpretations that exclude certain social groups, namely high-status individuals, from being active craft practitioners, simply because they lacked an economic incentive. Ultimately, this is rooted in the age-old intellectual preference for art over craft which, despite acknowledgement and lamentation, lingers on in academic discourse. It is necessary to make room in our interpretations for elite individuals who were not only patrons of master craftspeople and commissioners of great works of art, but also potential producers of artefacts themselves. Perhaps not all of the objects they crafted will necessarily meet our expectations in terms of aesthetic merit, but it is conceivable that these high-status practitioners may have numbered amongst their ranks some of the foremost specialists of their time. Although it is unlikely that hobby crafting in premodern societies, whatever form it took, had a substantial economic impact, at certain moments its social importance, therefore, may have been considerable.

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[86] Brysbaert, Hochscheid 2021, 16.

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Different but the Same. The Regional Model of Byzantine Mareotic Bathhouses and the Case of Marea T2.

Abstract

The town of Marea/Philoxenite was built on the southern shore of late Mareotis, stretching parallel to the coast of the Mediterranean Sea west of Alexandria and the Nile delta, as the last "monumental Byzantine urban project before the Arab conquest of the Eastern Mediterranean in the second quarter of the seventh century AD" (Gwiazda, Derda 2021). There, a Byzantine bath (Marea T2) was investigated in 2023, which represents a specific type of Late-Roman/Byzantine bathhouses defined by Bérangère Redon and Thibaud Fournet. While the principal aim of the present text is to report on the findings of the 2023 campaign, placing these latest discoveries in a proper context requires first discussing the 'regional model of Byzantine Mareotic bathhouses'.

Keywords: Byzantine Egypt, Byzantine baths, Mareotic baths, thermae, Marea, Philoxenite, Lake Mareotis

Introduction

In their 2017 paper titled 'Romano-Byzantine baths of Egypt, the birth and spread of a little-known regional model,' Bérangère Redon and Thibaud Fournet discuss the creation and subsequent development of a specific type of Late-Roman/Byzantine bathhouses,[1] which were geographically limited to the larger area around Lake Mareotis, located near the Mediterranean coast, 40 km west of Alexandria (Fig. 1).

The basis for defining such a 'regional model' are aspects of chronology, functionality and aesthetics. Currently, 11 bathhouses are tentatively thought to represent this model, two of which are located in Marea/Philoxenite,[2] that is, present-day Hawwariya (Fig. 2): *thermae* T1 and T2. While T1 is a quite typical representative of the Mareotic model and was excavated completely in 2000–2006,[3] T2 was only superficially investigated in the past.[4] In 2023, excavations at T2 were taken up again after three decades and already the first campaign showed that while this bath undoubtedly belongs to the aforementioned model, it also differs from it in a significant way that goes beyond slight alterations forced by the local circumstances.

Marea was "a well-planned town that took the basic needs of the civilian population into account, and the larger part of it was built within an urban planning project. It preserves the prevailing ideals of the time in its plan, with the presence of a large church adjacent to the most important street."[5] A significant part of Marea was built in the second half of the 6th century AD, indicating that it was the last "monumental Byzantine urban project before the Arab conquest of the Eastern Mediterranean in the second quarter of the seventh century AD", and thus appropriately dubbed a "swan song" by Mariusz Gwiazda and Tomasz Derda.[6]

The town plan covered an area of approximately 20 ha and included churches, a monumental street with

[1] Fournet, Redon 2017.

[2] 'Marea' is an established conventional name, but the place should not be confused with the Marea mentioned by Thukidydes (as the headquarters of the Lybian king Inaros; Thuc. 1.104.1) and recently 'Philoxenite' is slowly taking over as the proper ancient name of the site. *Cf.* Derda 2020, 61–63; Gwiazda 2023, 197 fn. 4.

[3] Szymańska, Babraj 2008.

[4] See Fournet, Redon, Vanpeene 2017, 487–488.

[5] Gwiazda, Derda 2021, 8.

[6] Gwiazda, Derda 2021.

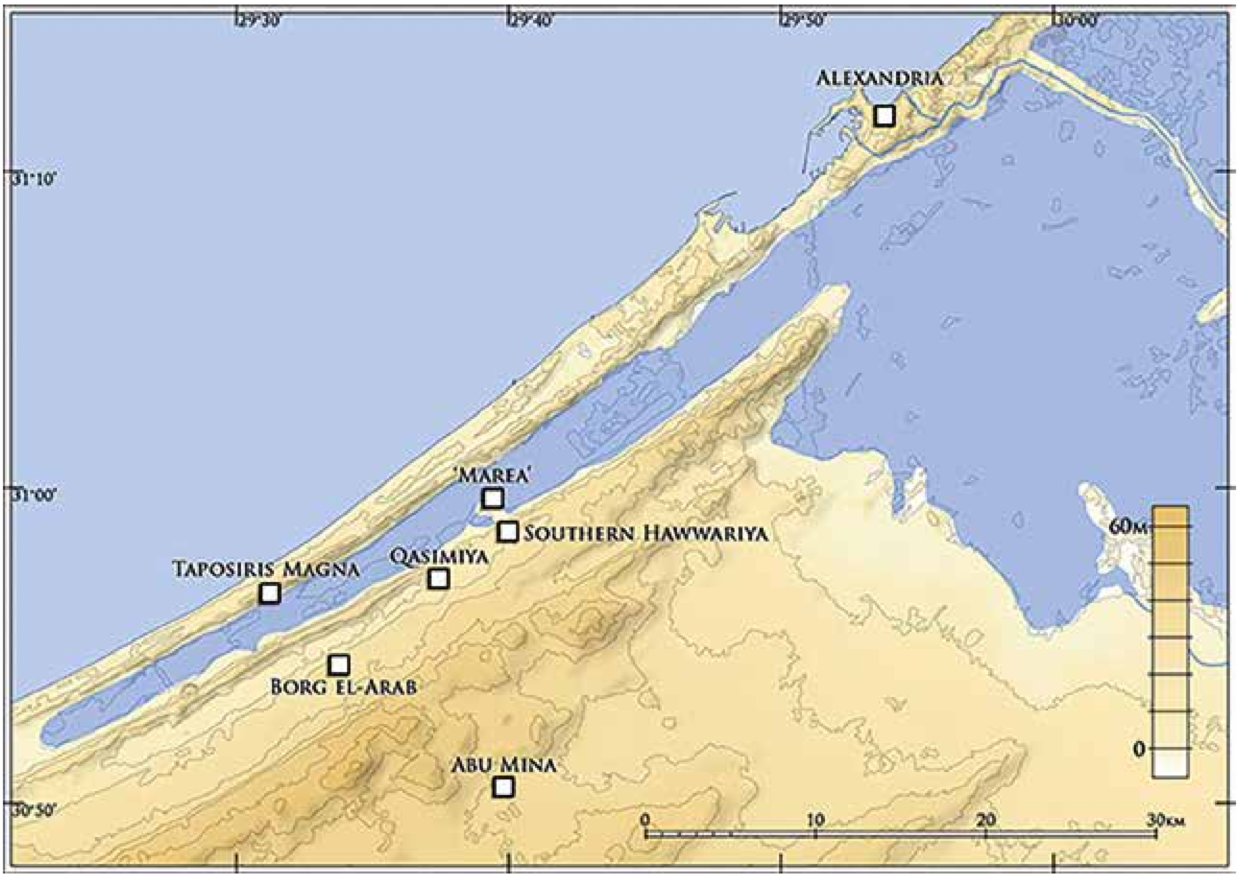

Fig. 1. Mareotis region (compiled by J. Kaniszewski).

adjoining buildings, and waterfronts with boardwalks and piers, complemented by several public latrines, a mill, and two bath complexes. However, the plan is not orthogonal: while the streets run in straight lines, they are oriented along the layout of monumental buildings. On the outskirts, farmlands with an irrigation system were identified hinting at a certain economic independence from the pilgrimage traffic.[7]

The present text reports on the architectural features and peculiarities discovered during the 2023 campaign in Marea T2. However, the observations can immediately be put into the context of the Mareotic baths postulated by T. Fournet and B. Redon. The outcome is a hybrid contribution combining the features of an excavation report with an architectural analysis. The lengthy introduction is justified in this approach first and foremost by the feature which makes Marea T2 stand out from the other Mareotic baths, namely the location of the *praefurnium*.

Bathhouse T2

The bathhouse at Marea labelled T2 (*thermae* 2) (Fig. 3) has been investigated in the 1970s and 1980s, first by Fawzi el-Fakharani, who initially identified it as a basilica,[8] and then by Mahmoud Sadek, who cleared the area around the two courtyards and was first to interpret the plan of the bath.[9]

This northern section of the *thermae* around the two courtyards will be hereafter referred to as the 'cold' and 'white' part of the bathhouse, as opposed to the 'hot' and 'red' part in the south (also called the "bathing block" by T. Fournet and B. Redon). The distinction goes back to the differing functionalities and building material: the southern part was built of red bricks (although during the operation period most of the brick walls would have been veneered with limestone or marble) and held the furnace and hot basins, while the northern part was built of white limestone and included the two *palaestrae*

[7] Gwiazda 2023, 197.

[8] Fakharani 1983.

[9] Sadek 1992.

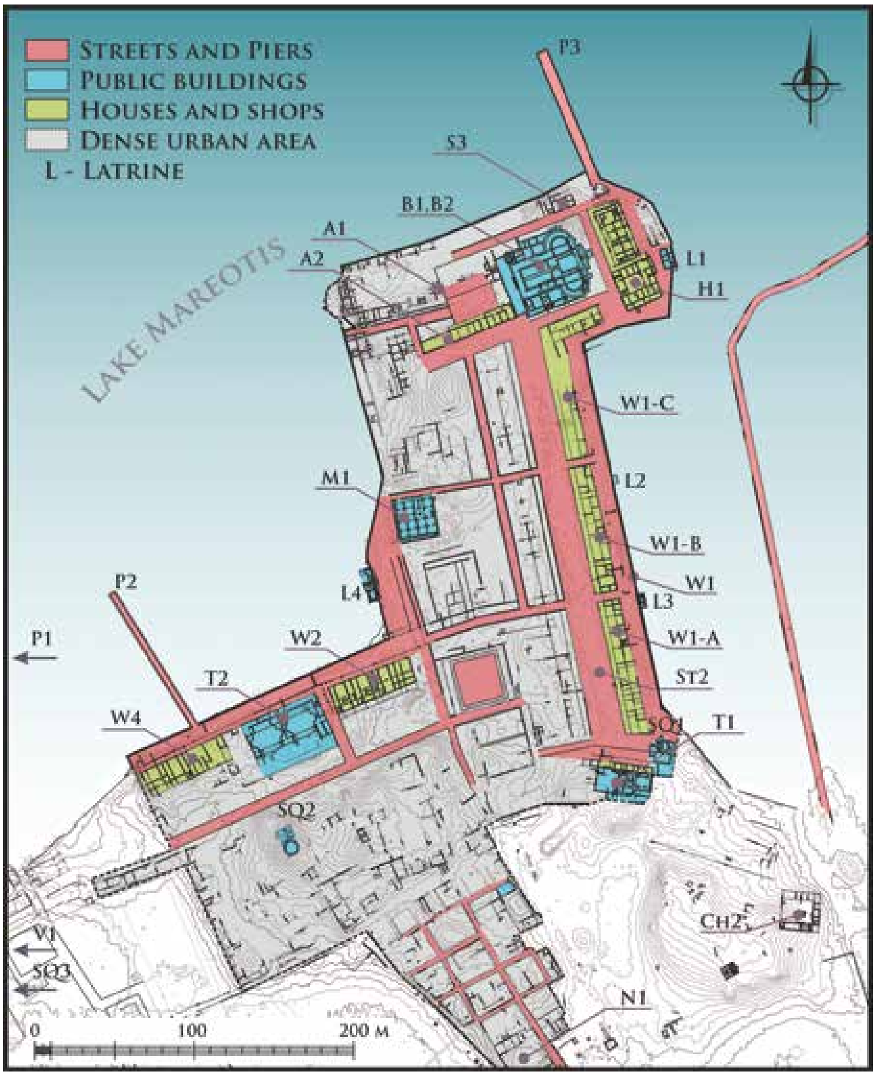

Fig. 2. Marea/Philoxenite (compiled by A. B. Kutiak, W. Małkowski and M. Gwiazda).

(M. Sadek: *exhedrae*) and several rooms and basins without heating.

Bath T2, whose visible features were precisely measured and drawn by Andrzej Kutiak[10] in 2021, has the total area of approximately 1850 m^2, with the white part being considerably bigger (approx. 1200 m^2) than the red (approx. 650 m^2 or 550 m^2, not counting the assumed *tabernae* in the east).

The excavations at T2 in 2023 encompassed two principal tasks: the clearing and cleaning of the earlier excavated white part and new excavations mostly within the red part. Given the double or twin layout of the white part, the decision was made to excavate around the central axis, that is, in the red part where the furnace was expected (trenches T2.1. and T2.3.) and in the white part where a room between the two courtyards had not been fully investigated earlier (trench T2.2.).

The "little known regional model"

T. Fournet and B. Redon defined the group of 11 bathhouses as the Byzantine baths of Mareotis based on the noteworthy "uniformity of their architectural and technical characteristics (…) they appear to be the culmination of a long evolutionary process (…)".[11] They appear in the second half of the 5th century AD and develop until the end of the 7th century, as attested for the sites: Abu Mina South; Abu Mina North; Ezbet Fath'Allah; Karm Kandara; Kom Khobeiz; Marea T1;

[10] Kutiak forthcoming.

[11] Fournet, Redon 2017, 280.

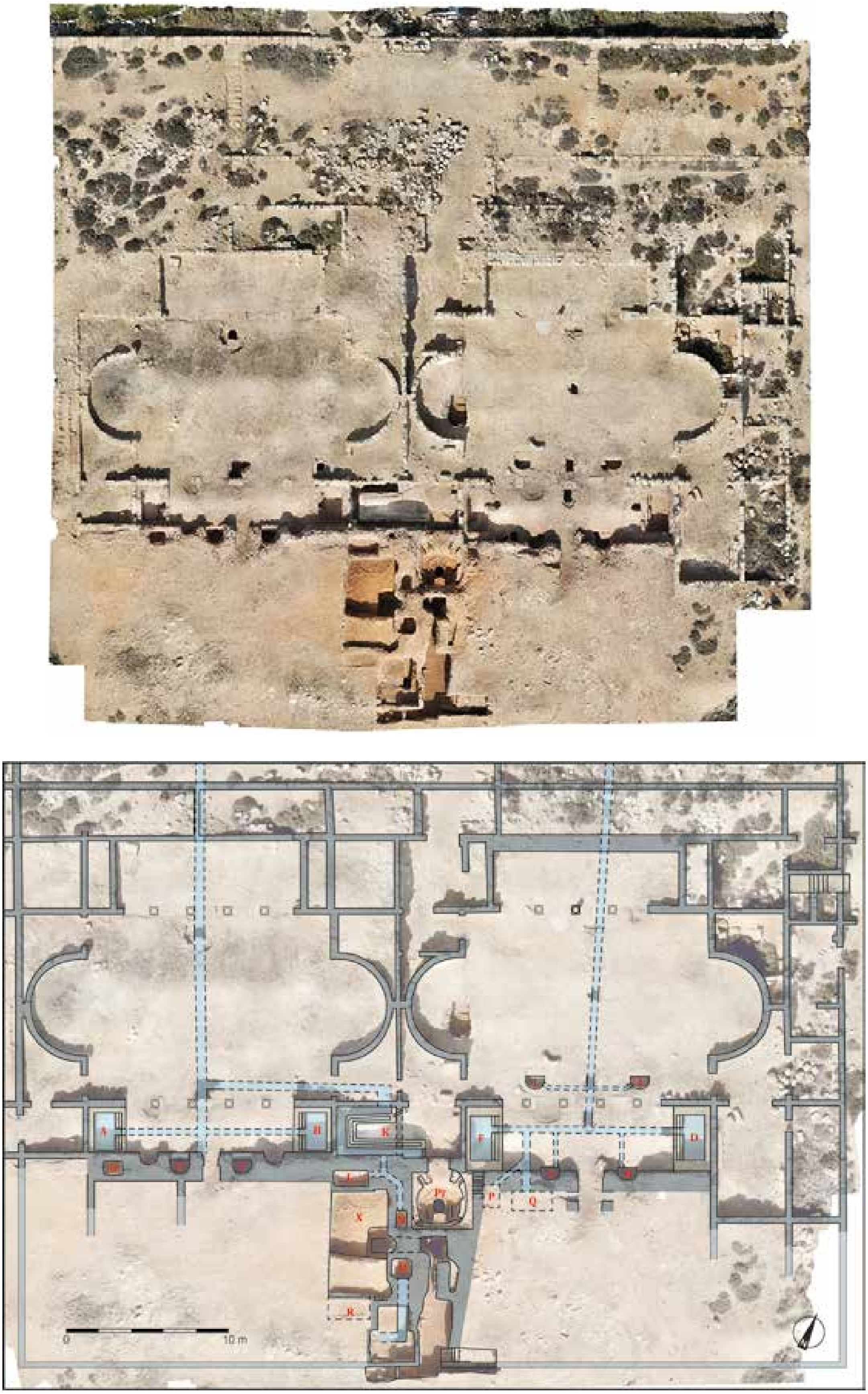

Fig. 3. Bathhouse T2 after the 2023 excavation campaign (A), with marked archaeological features and sections (B) (photo by T. Borowski, compiled by P. Zakrzewski).

Marea T2; Mergham; Mit Abul Kom; Taposiris Magna and Teiba.[12]

The researchers explain that the model developed between the 5th and 7th centuries in the region of Alexandria, more specifically around Lake Mareotis, and indeed seems to represent the culmination of a long process of successive transformations and adaptations of Egyptian baths, characterised by a standardisation of the edifices (Fig. 3). In their view, "Mareotis" is the region of the biggest concentration rather than exclusive appearance of these bathhouses, pointing to the example of Kom Khobeiz located in the north-central Nile Delta and also the possibility of other instances being found in the future outside Mareotis.[13]

In short, the authors say: "All these baths share the characteristic of having an asymmetrical plan and of presenting the bather with a row type itinerary; they also display a marked disproportion between a vast and monumental-looking cold section and a small heated section. The latter comprises one or two rooms equipped with deep, semi-circular or rectangular, individual bathtubs embedded in the walls. More than half the baths in this group have, in addition, the particularity of being doubled: two similar circuits are juxtaposed, or adjoining, thereby allowing the separation of the sexes".[14]

T. Fournet and B. Redon propose a rough rule that the hot part of the baths of Mareotis on average represents only 15% of the total surface area of the spaces open to bathers, not counting the service area.[15] This heated area ("bathing block") was preceded by an entry hall and a central courtyard with porticoes. Outside the heated area, but not far away, several small cold basins were located, while farther away one would find vestibules, cloakrooms, latrines and other utility rooms. The hot and warm section was completely built of fired bricks and covered by barrel vaults, while in the much more elaborate cold zone, both stone and wood were used for its numerous porticoes and a truly ornamented architecture.

The Hot Rooms

Inside the hot section the bathers would likely follow a 'fairly classic' bathing circuit, which – importantly – is also oriented in a circular fashion around the central furnace, so as to maximize the benefits of the heat. The various small bathtubs were embedded in the walls and could be semi-circular, semi-hexagonal or rectangular in shape. They were equipped with a bench-step to sit upon while being immersed up to the shoulders. While some benches could fit two or even three bathers, the majority of these bathtubs were intended for individuals.

This setup differs distinctly in its philosophy from the classic Roman *caldaria*, which were areas for collective relaxing. Fournet and Redon assume that the water in the individual bathtubs was changed more often that it would have been the case in the larger pools of warm and hot water in the Roman baths of the Principate.[16]

These changes with regard to the classical Roman bath layout certainly reflect limitations in access to water, and heating large amounts of water at the same time in particular. However, the small, one-person bathtubs are also a moral statement, which distinguishes Byzantine bathing in general (to which the Mareotic group belongs) from the more libertarian philosophy of the Principate. Philipp Niewöhner formulated this paradigm shift compellingly in his observations concerning a division of rooms in the Southern Bath of Milet: "In the Late Antique and Byzantine repair phases II and III, the aim was (...) to divide the baths into two separate wings, probably so that men and women could bathe at the same time but separately from each other. It is likely that this was not associated with austerity, and the establishment of double baths indicates that personal hygiene was still highly valued and that the necessary infrastructure was maintained. However, it seems that body care was now mainly limited to hygiene and getting warm, whereas the complex procedure of bathing in the imperial era corresponded to a more 'holistic concept of wellness'. This reveals a shift in thinking that also appears in numerous statements against bathing luxury at the time, which can mainly be linked to the problematic role of the body in the Christian salvation theory. Thus, the Byzantine conversion of the southern thermae from a complex spa complex into a simple balneum was not determined by economic decline, but by a changed conception of the body. Philosophical factors may have had a greater influence on the end of the ancient baths than is sometimes assumed".[17]

Naturally, the division of baths by the sexes was a standard procedure in Republican and early Imperial times as well[18] (even if not implemented as dogmatically), for example in the famous Stabian Baths at Pompeii, but the removal of the concept of leisure bathing as a community function was now a thing of the past.

[12] Fournet, Redon 2017, 281–282.

[13] Fournet, Redon 2017, 283.

[14] Fournet, Redon 2017, 283.

[15] Fournet, Redon 2017, 283.

[16] Fournet, Redon 2017, 284.

[17] Niewöhner 2015, 234 (translation: M.L.).

[18] *Cf.* Yegül 2010, 22–39.

Thus, after a hot but lonesome bath, the bathers in the Mareotis region returned to the large courtyard with porticoes to enter pools or individual immersion basins of cold water. Fournet and Redon observed that there were two to six basins arranged symmetrically on either side of the door leading to the hot section, again located in niches in the façade of the 'red part'.

Double Baths

The much quoted authors also noted that of the 11 baths belonging to the Mareotic group, seven have two completely independent circuits, which sometimes are almost identical in layout.

The logical interpretation of this doubling is that the bathers were divided by sex; men and women, who until then would have had to share the same edifice, with different opening hours. Now each had their own space, available anytime. This also doubled the capacity of the buildings. T. Fournet and B. Redon point out that in at least four of the seven examples (Abu Mina South, Mergham, Mit Abul Kom and Taposiris), the doubling happened in a second phase: originally they were 'unipartite' edifices to which a second circuit was added.[19]

Marea T2's belonging in this group requires separate consideration. T. Fournet and B. Redon marvel at the "perfect symmetry of the two circuits, arranged parallel to one another", enhancing "the monumentality of the edifice, which must have occupied a surface area at least equivalent to that of the main baths of Abu Mina South (the cold sections alone cover over 1000 m^2)".[20] They might be right in claiming that the builders did not have to adapt to a restrictive urban environment, allowing for such monumentality, which was in line with the general development of the town quarter. But on the other hand, under close inspection the symmetry turns out not quite perfect, with the recess in the main E-W wall partitioning the hot and cold parts, as well as other details, raising the question whether an initial single bath was duplicated here after all.

The Heating System

Within the group of Mareotic baths, the construction techniques are visibly uniform – fired bricks in the hot sections are used from the foundations up to the vaults, constituting the base for the cleverly devised heating technology.

This technology is naturally reminiscent of 'traditional' Roman baths, in that it uses furnaces (*praefurnia*), sometimes with a boiler on top, linked to a system of hypocausts and heated walls. But many details are different: the arrangement of the furnaces, the fuel and the manner in which the heat was distributed. The *praefurnium* of a Mareotic bath is located at a much deeper level than in the baths of the Principate or even many Byzantine baths. In the depth, they were surrounded by utility rooms in actual basements under the bathing rooms. T. Fournet and B. Redon note how "this distinctive feature meant that the furnaces could be placed at the centre of the edifices rather than in a peripheral position" and the "central position of the furnaces permitted by this layout is particularly adapted to double edifices, whose two circuits are arranged around this 'central' heating".[21] The combustion chamber of these *praefurnia* was, because of this location, significantly taller than that of older Roman furnaces, although a comparable solution, dubbed "high-flame furnace" by the excavator Wojciech Kołątaj, was found in the Byzantine main baths of Kom el-Dikka (Alexandria),[22] which are not part of the Mareotic group, but likely faced the same problems regarding availability of fuel.

In the Mareotic group, the principle furnace was located at the centre of the hot section and had a boiler above it to heat the water for the bathtubs, although in larger buildings, additional furnaces were used as well. The boilers were made up of one, two or four circular metal bottoms, each around 60 cm in diameter, topped with a masonry cistern, a structure which leaves behind very characteristic traces in the archaeological record. The largest edifice (Abu Mina South) contained four furnaces, two of which had boilers, so additional furnaces can be expected to be found at Marea T2 in the future.

The furnaces with boilers had their own chimneys, "going up vertically around the reservoirs, as well as a conduit opening onto the hypocaust: it was no doubt possible to modulate their working by adjusting the opening of these chimneys, to improve the heating of the water or of the rooms according to need".[23]

The hypocausts of Mareotic baths are quite unlike the instantly recognisable hypocaust cellars dotted with small pillars of pedales bricks of the Republic and Principate. They consist of parallel rows of brick vaults that are connected with each other only at a few points. T. Fournet and B. Redon convincingly argue that such

[19] Fournet, Redon 2017, 286–287.

[20] Fournet, Redon 2017, 286.

[21] Fournet, Redon 2017, 287.

[22] Kołątaj 1992, 176–178; *cf.* Fournet, Redon 2017, 287.

[23] Fournet, Redon 2017, 288.

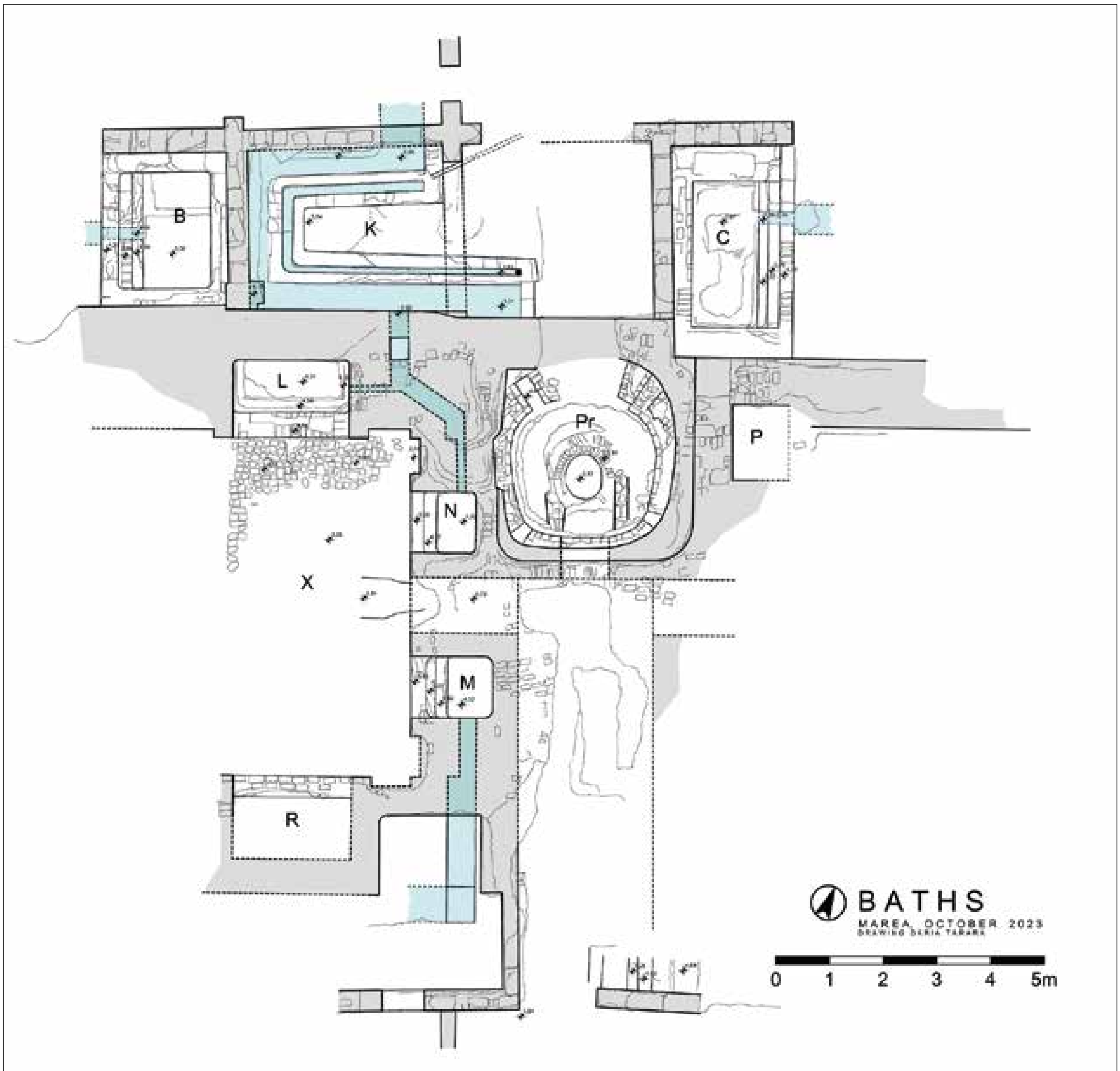

Fig. 4. Fieldwork areas in 2023 (drawing by D. Tarara).

a construction "was probably more resistant and avoided the need for specific materials: the commonly available bricks, used equally for building the walls and the vaults, were used here in this installation thereby precluding the need for round bricks or bipedales".[24] This was possible, because the small hot basins were not built on the hypocaust floor and thus not heated from the ground, and so could be deeper than before. This choice again goes back to the solitary bathing philosophy: the water was changed more frequently than in the large pools of the Roman baths, hence it was not necessary to maintain the temperature of the basins through underground heating, opting instead for a fresh supply of hot water from the boilers when needed.

The position of the boilers in relation to the basins is also very different from the Roman model and crucial in the general Mareotic concept. Since there was no communal pool with warm or hot water, the boiler had to be located centrally and supply the numerous peripheral bathtubs.

[24] Fournet, Redon 2017, 288.

T. Fournet and B. Redon conclude, stressing the "remarkable standardisation from one edifice to the next in the Mareotic group: all share the use of the 'high-flame furnace,' vaulted hypocausts and heating chimneys. The majority place the main boiler in a central position, which supplies hot water to the small bathtubs in the bathing block. This standardisation logically reflects the one observed in the plans of these edifices, for they too, with greater or lesser means and ambition, follow common principles of organisation".[25] It can be traced at Marea T2 as well, but there is one crucial aspect in which the latter bathhouse differs, as we will see below.

The Marea 2023 campaign

All excavated areas mentioned in the introduction (Fig. 4) yielded interesting results. The furnace indeed was located at the expected spot (although given the overall size of the compound and the fact that – as we have seen – two furnaces are not uncommon in the Mareotis-type baths, including bath T1 in Marea,[26] a second *praefurnium* might be discovered in the future), while the excavations in the white part revealed a latrine. Additionally, cleaning up the white part brought interesting observations regarding the water management and marble decorations of bathhouse T2.

T.2.1 Room X

Trench T2.1. (Fig. 5) revealed a large room within the 'red' part of the bathhouse, likely one of the utility rooms for the *praefurnium*. Its eastern wall was uncovered in its entirety, that is, on the length of 6.30 m, while the perpendicular northern and southern walls were

Fig. 5. 'Room X' as seen from the south-west. Visible are basins L, M and N, as well as the archway towards the *praefurnium* (photo by M. Lemke).

[25] Fournet, Redon 2017, 289.

[26] Szymańska, Babraj 2008.

3.70 m long each. The western wall, however, has not been unearthed so far. All were built of bricks measuring 23×10×7 cm. In the centre of the eastern wall, a vaulted passageway towards the utility room south of the furnace (Pr) was discovered, while both the north-eastern and south-eastern corners of the room were flanked by niches with a width of 0.65 m and a recess of 0.15 m.

The area, dubbed 'room X', has to be considered a part of the basement of the bath, as the crown of its walls is level with the entry to four basins for hot water adjoining it from the north (L), east (M and N) and south (R) within the very same brick structure, at a height of approximately 5.30 m a.s.l. While the floor of the level above the cellar is missing entirely, the pavement of room X, made of bricks, was discovered preserved along the northern wall on the level of 3.67 m a.s.l. This pavement was repaired or replaced with a second layer of bricks set in a levelling layer of sand at 3.74 m a.s.l. Future excavations will show whether this pavement is the remains of a vaulted hypocaust floor.

Likewise, two phases can be distinguished in the walls of the room, to a point where it is unclear whether the architecture of the bathhouse was repaired/modified – somewhat awkwardly – above the preserved earlier phase (which ends at the height of max. 4.48 m a.s.l.), or if the earlier phase stemmed from a different building altogether, which had been adjusted to accommodate the 'hot' part of the *thermae*.

Either way, a decline in building technique is clearly visible. Both phases consist of the same brick type mentioned above, but the brickwork of phase 1 is neat and even with a solid wall footing at 3.01 m a.s.l., while phase 2 displays far thicker beds and perpends (albeit of a similar greyish mortar with an aggregate of crushed ceramics, gravel and seashells) and hence a less tidy workmanship. A trial trench in front of the passageway revealed a canal-like structure running below the cellar floor (2.64 m a.s.l.), possibly towards the furnace, which likely served as a connection to a hypocaust running westwards.

The walls of the ground floor of the entire 'red' portion of the bathhouse have been severely damaged – they are now preserved up to the height of 6.02 m a.s.l. in between basins L and N, just off the north-eastern corner of room X.

Fig. 6. Latrine (photo by M. Lemke).

T2.2. The latrine (K)

The rectangular room (7.50×3.00 m) in between the twin partitions of the 'white' part of the bathhouse, whose southern wall is the northern wall of the 'red' part, turned out to be a latrine (Fig. 6), albeit one that had been partially excavated in Sadek's times and then refilled.[27] The latrine could be accessed through the southern passageway connecting the eastern and western *palaestrae*. It consists of a small antechamber at the eastern end as well as the latrine proper, a characteristic rectangular 'island' of brickwork (4.80×1.90 m) surrounded by a 0.50 m wide sewage canal on three sides, whose water inlet were the drains of basins L and N in the 'red' part, while the outlet was connected to the western main canal of the *thermae* under the western *palaestra*.

The central block was built of bricks bonded with a greyish hydraulic mortar and topped off with a layer of light grey mortar that covered the floor and a gutter meant for cleaning the infamous sponge sticks used for washing oneself after the act. The outlet of this gutter poured water into the easternmost part of the canal encircling the latrine. Above the canal were the seats, probably made of wood, which are not preserved. Only their supports are protruding from the walls, as well as the remains of an arch that spanned the toilet along the central N-S axis of the bathhouse, supporting its roof.

T2.3. The furnace (*praefurnium*)

The furnace or perhaps rather *a* furnace of the bathhouse (Fig. 7) was located just off the central N-S axis of the bath towards the east, flanked by the antechamber of the latrine in the north and room X in the west and accessed via a vaulted corridor from the south. While the overall surface area of the *praefurnium* is approximately 3.50×3.20 m, the construction is typical of the Mareotic group of *thermae* in that is consists of a high, almost cylindrical combustion chamber in the centre (1.57 m high and ovoid in section with a diameter ranging between 0.80 and 0.60 m). Such chambers were a standard element of the aforementioned 'high-flame-furnaces,' topped off with a quadruple boiler, whose metal bottoms left a characteristic mark and were supported by a suspension frame set in four niches created in the outer wall.

Importantly however, the *praefurnium* is not set as deep in comparison to the bathing rooms as in other Mareotic baths and remains in a semi-peripheral position overall (see below). The space in between the combustion chamber (built of bricks covered on the inside with a layer of grey heat-resistant mortar) and the walls of the room was filled with *opus incertum*, leaving access through a corridor approximately 1.00 m wide, entering from the south and enclosed by a vault connected to the service opening of the combustion chamber.

The basins

During the 2023 campaign, a total of 17 basins were documented, 14 of which were cleared – the majority for a second time following previous investigations, though some were probably cleared completely for the first time. All were built of bricks bonded with and covered in a reddish hydraulic mortar. There are four bigger rectangular basins (A, B, C and D), probably *frigidaria*, two in each wing of the 'white' part of the twin bath. The eastern pair – C and D – are slightly bigger (approx. 2.65×1.75 m, 1.40 m deep) than the western – A and B (approx. 2.30×1.75 m; 1.22 m deep). Set in the wall separating the two principal areas were four small (radius: 1.00 m, depth: 1.20 m) semi-circular basins (E, F, G and H), designed to be used by one person at a time, which can be assumed to have been *tepidaria* or *caldaria*. Four rectangular basins (*caldaria*) with rounded corners were set in the walls around room X (L, M, N and unexcavated R), west of the *praefurnium*. They were slightly uneven in size (2.10–1.15×1.05–0.75 m, respectively), while to the east of it two more (P and Q) were identified but not excavated. Finally, two very small semi-circular basins (I and J), likely *frigidaria*, with a radius of merely 0.86 m were (re)discovered in the eastern *palaestra*, just north of the southern portico.

The majority of these basins originally had marble veneers, small fragments of which were noted in several instances. Exceptions are basins E and F in the apparently slightly inferior western twin portion of the 'white' part, which show no traces of ever being furnished with marble, as well as basin I (Fig. 8), where the marble veneer was almost completely preserved, including a tub-shaped marble monolith lying next to it on the surface. The drain was destroyed like in all other basins.

Water management

The water necessary for operating the bathhouse was acquired from a *saqqiya* located 62 m to the south of the furnace on a slight elevation (approx. 9 m a.s.l.). Directly below the *saqqiya* are the remains of two cisterns. Neither the aqueduct connecting these with the assumed *castellum aquae* in the bathhouse nor the conduits used for

[27] Solieman 2004.

Fig. 7. *Praefurnium* (photo by T. Borowski).

Fig. 8. Basin with intact marble veneering (photo by T. Borowski).

distributing water to the boiler(s) and other outlets have been discovered so far.

However, a lot can be said about the system of sewers used for disposing of the water into Lake Mareotis. All of the basins seem to have been equipped with lead pipes siding the drain between the basin and the sewage canal, that is, on a stretch of approximately 0.50 m. Unfortunately, the lead was salvaged and reused when the bath fell out of operation (like in Abu Mena[28]), inflicting considerable damage to both the basin as well as the floor of the bath. The remaining gaps and holes, combined with the fact that the sewage canals were built large enough to accommodate a person servicing them moving around, allowed for accurate observations in this part of the water management system.

The canals (Fig. 9) are 0.85–1.10 m high, 0.52–0.55 m wide and, with a few exceptions, have a very low gradient. From all the basins, as well as the latrine, the canals run northwards to connect to one of the two main sewers running along the N-S axis, roughly underneath the centre of each *palaestra*. The eastern one had been visible for decades, while the western canal tops located

[28] Müller-Wiener *et al.* 1967, 174 fn. 3.

Fig. 9. One of the cleared main sewers (photo by M. Lemke).

near the lake were uncovered only during the 2023 excavation season. Their beginnings, which lie under the 'red' part, have not been discovered so far. A certain exception is basin M, whose canal leads towards the south and west, but it likely also connects with the western main sewer in a hitherto unexcavated area.

The side walls and the bottoms of the canals were built of stone. Up to the line of the stylobates of the two southern porticoes the canals are vaulted with bricks, but to the north of them – up to the lake shore – they are covered with stone slabs, with particularly massive monoliths below the stylobate, suggesting that they were designed to withstand additional pressure.

Observations on architecture and decorations

While the 'white' part of the bathhouse is significantly larger than the 'red,' the proportions are nowhere near the common average for Mareotis-type baths, where the "bathing block" represents "only 15% of the surface area of the spaces open to bathers".[29] This renders the bathhouse Marea T2 a more balanced structure. Another departure from the Mareotis-type characteristics notable in this context is that bathhouse T2 consciously foregoes the principle of maximum heat exploitation achieved by 'wrapping' the hot part completely around the furnace and then the cold part around the hot part. Instead, it sacrifices the easily heated space north of the *praefurnium* in favour of arranging both parts of the bath on either side of a lengthy E-W axis, valuing monumentality over functionality. This layout will remain intact, even if a second furnace is uncovered in the western part of the 'red' area in the future.

The 'white' part of the bath was almost entirely clad in marble – small patches of the marble floor have been discovered, while in other places the characteristic perpends and beds in the mortar layer on the ground show the outline of the marble slabs once placed there.

The Modular design in Marea

The aforementioned characteristics of monumentality and symmetry in bath T2 fit very well into the overall layout of Marea/Philoxenite. The "widespread use of duplicate floorplans leaves no doubt as to the nature of these foundations. They were certainly not individual building projects, but buildings constructed as part of a larger urban programme that covered an extensive part of the town".[30] At the same time, the hospital at Marea, together with the two baths and the considerable number of latrines, indicates that the health and comfort of the residents were valued greatly by the planning architects.[31]

The modular design was rooted in the traditions of the Roman and Early Byzantine periods, when it was used primarily for shops (*tabernae*), warehouses, and cisterns.[32] All the modular buildings in Philoxenite are located in its northern part, near the lake, covering approximately 5 ha, that is, almost half of the urban area.[33]

Its significance for Marea also highlights a completely different aspect; M. Gwiazda argues that the architecture of Marea/Philoxenite reflects the influence of the pilgrimage movement on the development of towns of the early Byzantine Period. "The large-scale use of modular design at the site aided in urban planning, and today it helps us determine the way the entire district was constructed in order to serve the needs of pilgrims. Philoxenite thus yields new insight into the influence of Christianity on Late Antique urban planning and the way that new cities were created".[34]

[29] Fournet, Redon 2017, 283.
[30] Gwiazda, Derda 2021, 6.
[31] Gwiazda, Derda 2021, 6.
[32] Gwiazda 2023, 196.
[33] Gwiazda 2023, 198–199.
[34] Gwiazda 2023, 196.

While the convenience and ease of execution provided by the use of repetitive plans in architecture may seem evident, the fact that the idea shaped Marea/Philoxenite is far from trivial. One should note that historically "the modular building technique was primarily used in structures associated with trade and storage. It is poorly attested in the case of private residential complexes. Moreover, modular design seems to have been used in larger public and sometimes military construction projects".[35] As a matter of fact, Marea/Philoxenite is unique, because no other site is known to exhibit the modular design implemented on such a large scale.[36]

Conclusion

In the case of a bathhouse, there can be more than one reason for the repetitive or modular nature of the twin plan: aesthetics, the division of the sexes, chronology or the duplication of the floor area, for instance to accommodate an unexpected increase in the number of clients. The latter is corroborated by the visible differences between the twin portions, which are difficult to explain otherwise.

However, in general, the bathhouse T2 in Marea appears to combine the 'best of both worlds': following the rules of the Mareotic bath model for its cost-efficiency (and moral integrity), while at the same time circumventing some rules in order to fit into the monumental building style along the 'corniche' of Marea.

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[35] Gwiazda 2023, 207.

[36] Gwiazda 2023, 210.

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The Gareus Temple from Uruk: Some Observations Concerning the Temple Attribution

Abstract

To the south of the main hill overlooking the ruins of Uruk is the Temple of Gareus. Dated to either 422 SE or 110/111 AD, the temple is attributed solely on the basis of a Greek inscription found inside it. The temple and the deity worshipped therein are of particular interest, as they represent some of the most enigmatic deities from the times of Parthian domination over southern Mesopotamia. It is possible that its origins are rooted deeply in the Mesopotamian religious tradition.

Keywords: Uruk, Parthian Period, temple, religion, Gareus, architecture

The site of Uruk, which is considered to be one of the most significant cities of the ancient Near East, has gradually come to be seen as a symbol of the study of southern Mesopotamia's past, thanks to the dedicated efforts of many researchers over many years.[1]

The research carried out at this vast site has revealed remains and evidence of the settlement and development of the city in the first centuries AD. One such architectural monument is the Temple of Gareus, which was found near the south-western outskirts of the city.[2] The location of the temple, and its significance for the urban community, have been the subject to detailed analyses. The same can be said of the building itself, which is one of the most interesting religious structures ever found in the area of present-day Iraq.

The temple is situated on a hill lying south-east of the two most important religious complexes, Bit reš and Irigal (Fig. 1). The hill on which the Temple of Gareus was built is separated from the main tell by a hollow. It is possible that a defensive wall may have existed in the immediate vicinity of the temple, though it is probable that this was no longer the case at the time of the temple's construction. Nonetheless, traces of the wall are still visible in the field.

The temple

It seems likely that the temple was built around 111 AD, and that at this time a *temenos* wall was also added to surround it.[3] It is worth noting, however, that some have suggested dating the inscription according to the Parthian calendar, which would place it in 175/176 AD. This, however, seems less likely.[4] The *temenos* wall is more akin to a fortification than an enclosing element of a sacred building (Figs. 2, 3). The wall enclosing the sacred space, like the temple itself, was made of burnt bricks. The outline and construction of the *temenos* wall appear to be unique, bearing no resemblance to any *temenos* known from across not only Mesopotamia but also other parts of the Near East. The plan of the wall itself, behind which the *temenos* of Gareus was erected, is roughly square in form. The dimensions of the entire structure are thought to have been 60 × 52 m.[5] The façade of the *temenos* wall was carefully decorated with semi-circular imitations of defensive watchtowers, two on each side of the wall, and the corners additionally finished with round towers that also closely imitate military buildings. This architectural choice suggests that the building was deliberately designed to resemble

[1] Crüsemann *et al.* 2013.
[2] Downey 1988, 137–144; Kose 1998.
[3] Meier 1960.
[4] Merkelbach, Stauber 2005, 119.
[5] Kose 1998.

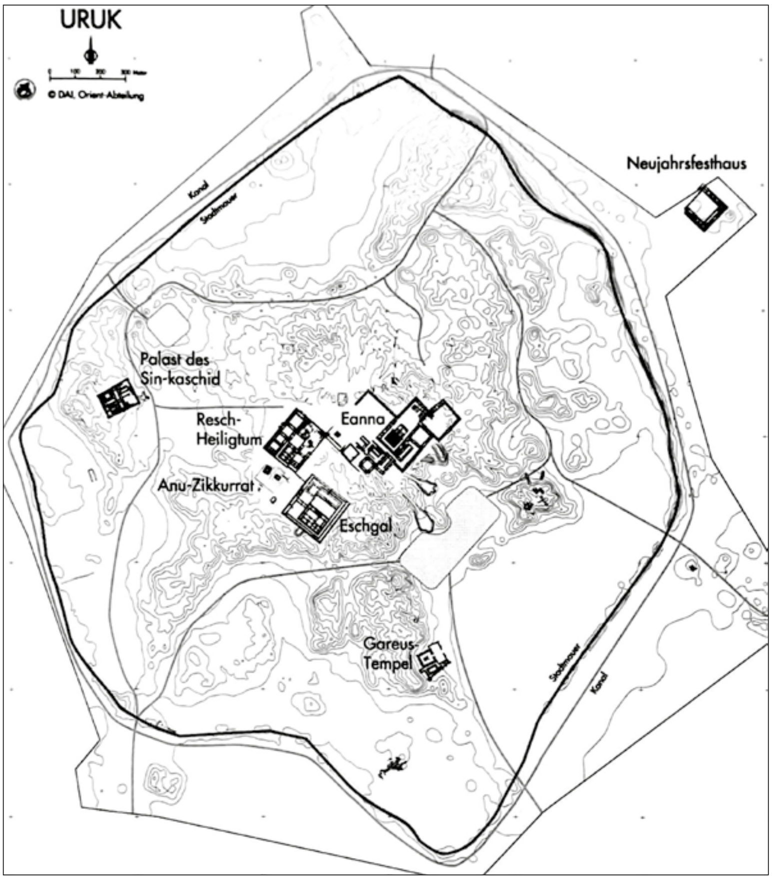

Fig. 1. Uruk, general plan (after: Crüsemann *et al.* 2013, fig. 1).

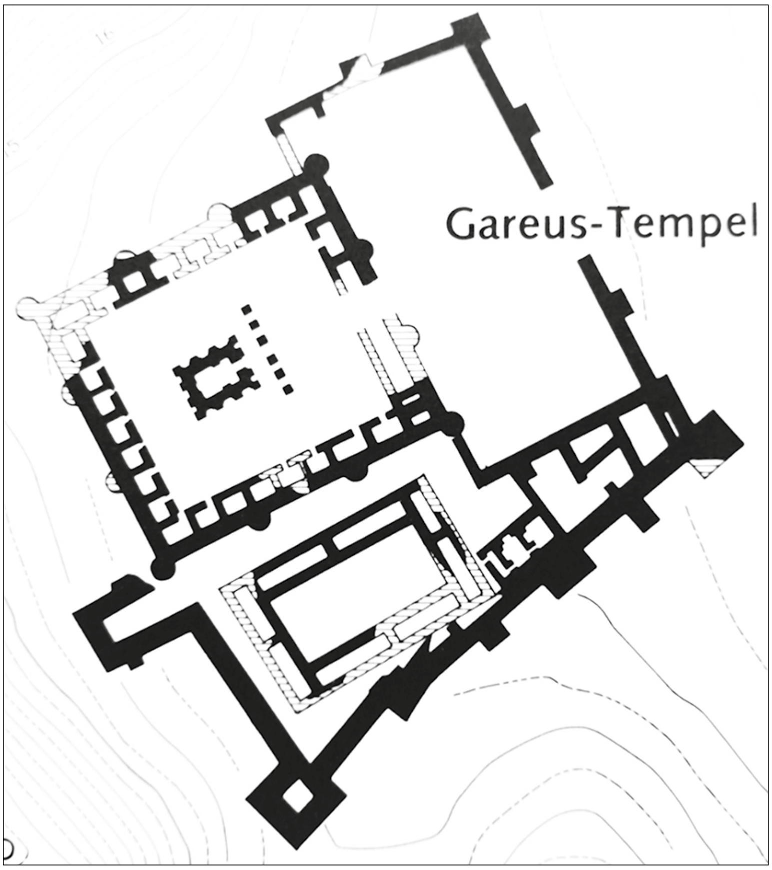

Fig. 2. Temple of Gareus, the whole complex (after: Crüsemann *et al.* 2013, fig. 1).

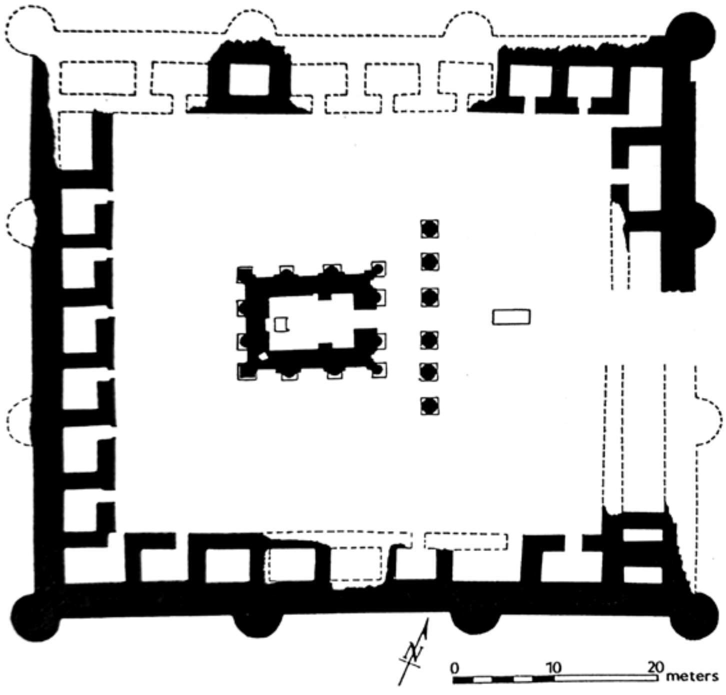

Fig. 3. Temple of Gareus, floor plan (after: Downey 1988, fig. 62).

a defensive structure rather than a building dedicated to religious purposes.

The sanctuary was accessed through an entry in the eastern façade of the *temenos* structure, as the partially preserved architectural structures show. Entering the interior of the complex, a striking temple can be seen on the axis of the entrance. The numerous rooms adjoining the inner side of the wall surrounding the sacred building also draw attention. Surprisingly, these rooms are mostly very similar in size and surround the entire courtyard. The *temenos*'s design evokes military architecture, with the central space occupied by the temple, which is surprisingly small at 10.50 × 13.70 m.[6] Despite its modest size, the temple is adorned with elaborate exterior features. The decorative semi-columns or pilasters, as well as the architectural elements placed in the corners, correspond in a certain way to the external decorations of the *temenos* wall. A similar visual is at work in the wall surrounding the temple, albeit on a reduced scale. The outer wall clearly has additional architectural details that were deliberately added to the inaccessible, hidden temple behind it. The inner space demonstrates features of sacred architecture from the Babylonian tradition. The most important element was the main axis of the temple, which led from the entrance towards a niche in the back wall. In front of this niche, the remains of a podium have been preserved, on which a statue of the deity had certainly been placed. The temple's most distinctive feature is the group of six columns that were erected in front of the sanctuary's façade (Figs. 4–5). These columns, which completed the temple's architecture, were free-standing and did not support any structural elements. This gave the temple façade, despite its modest dimensions, a more monumental character than one might expect by looking through the entrance to the entire sacred complex.

The *temenos* wall, which resembled defensive structures, was not the only monumental element that determined the image of the southern part of the residential quarter. The remains of this wall are still visible in the landscape of Uruk to the south-west of Irigal and Bit Reš. Two more architectural complexes directly adjacent to the *temenos* temple walls stood out in the urban landscape. Together, these structures formed an entire architectural complex that divided the space adjacent to the *temenos* into three parts. In front of the *temenos* wall, where the gate to the temple was located, a rectangular structure was erected, also finished with buttresses or large avant-corps, clearly resembling a defensive building. No structures could be found inside this space, which clearly takes the form of a courtyard. It was evidently meant for religious

[6] Schmidt 1970.

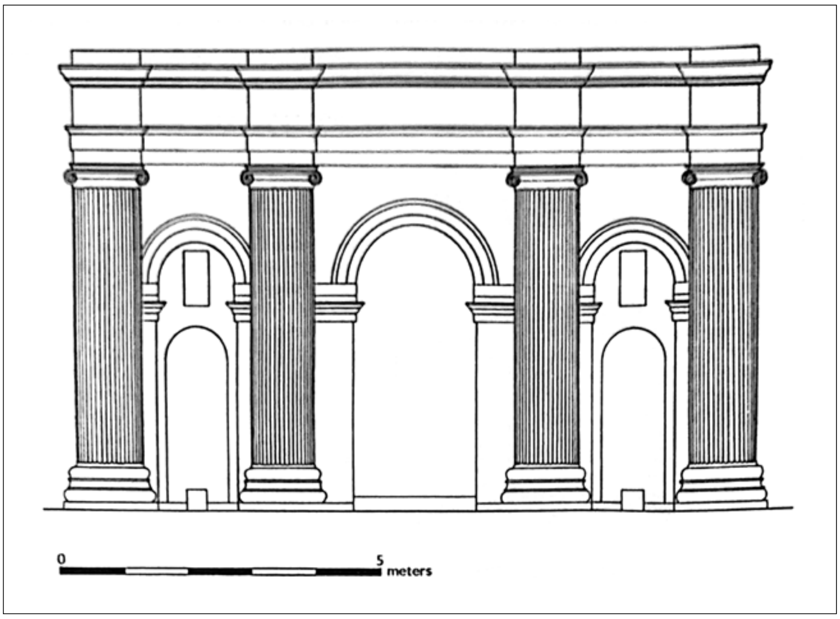

Fig. 4. Temple of Gareus, reconstruction of the northern façade, variant 1 (after: Downey 1988, fig. 60).

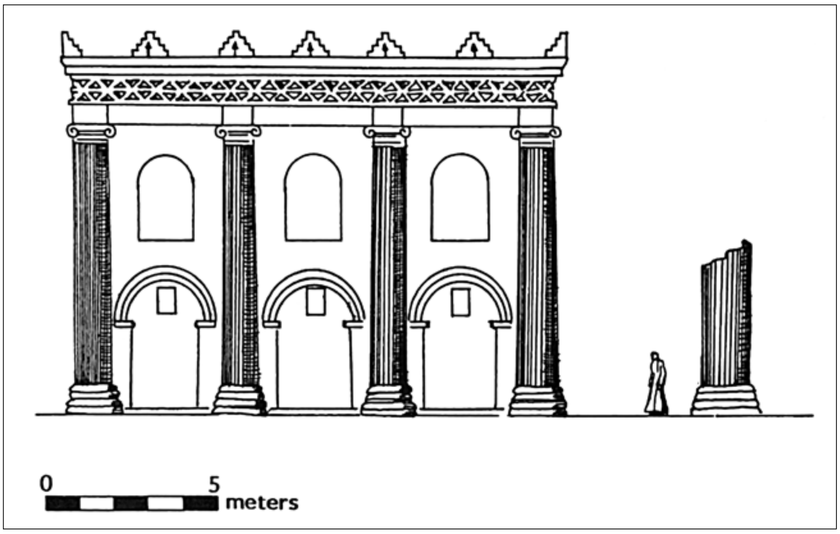

Fig. 5. Temple of Gareus, reconstruction of the southern façade, variant 2 (after: Downey 1988, fig. 61).

purposes or may have been used for religious rituals and ceremonies that are currently unknown. The rectangular shape of the courtyard is wider than the *temenos* wall. This suggests that the additional architectural element dominated, or rather obstructed, the *temenos* wall with the entrance to the temple area.

The second structure, erected on the southern side, is built on a somewhat irregular plan and no longer has such elegant proportions. This part of the complex is best described as trapezoidal. It is clear that it must have looked like a military building, as the walls, buttresses, bastion, and square corner towers are among the most massive architectural elements used in the construction of the entire temple complex. Behind the walls of this part of the complex were several structures, the most important, and certainly the largest, of which is the rectangular building with a central courtyard. If the interpretation is correct, the courtyard was surrounded by narrow rectangular rooms. The other building, much more modest, is a dwelling house squeezed between the walls in the eastern part of the complex under discussion.

The inscription discovered in the temple

The temple was attributed based on the discovery of a Greek inscription within the structure. The translation, collation, and commentary were all undertaken by Christian Meyer, who published his research in

Baghdader Mitteilungen in 1960.[7] The inscription in the ruins clearly indicates that Gareus was worshipped there. The text itself is an honorific inscription, containing not only the name of the deity but also additional details.

ἔτους βκυ', μηνὸς Δείου.
Ἀρτεμίδωρος Διογένους ὁ
ἐπικαλούμενος Μινναναιος
Τουφαίου, στοιχῶν τῆι τῶν προ-
γόνων αὐτοῦ ἀγαθῆι προαιρέσει
ἀνέθηκεν Γαρει θεῶι χωρίον Δα-
ιαμεινα. τὸ δέ κοινὸν τῶν
Δολλαμηνῶν, ὃν εὐχά-
ριστον, ἔκρ{ι}εινεν ἀμεί-
ψεσθαι ἀντί ἀναθήματος ἀν-
δριάντα αὐτῶι στῆσαι ἐν ναῶι Γαρεως,
στεφανοῦν τε αὀτὸν ἐν ἑκάστηι γε-
νεθλιακῆι αὐτοῦ τὸν σύμπαντα χρόνον,
οὔσηι ἕκτηι Ἀπελλαίου, παρειστᾶν αὐτῶι
ἱερόθυτον καὶ ἀπὸ τοῦ αὐτοῦ ἱερο-
θύτου πέμπειν αὐτῶι Ἀρτεμι-
δώρωι ὀσφὺν εὐσεβείας
καὶ εὐνοίας ἕνεκεν.

In translation, the text can be read as proposed below:

In the year 422, in the month of Deios. Artemidoros, son of Diogenes, also called Minnanaios, son of Touphaios, following the good principles of his ancestors, dedicated the estate of Daiamenia to the god Gareus; the Koinon of Dollamenians, however, gratefully resolved to reciprocate the gift: to erect a statue to him in the Temple of Gareus and to crown him on every birthday of him who is the sixth Apellaios, for all time to provide him with a sacrificial animal and to send him, Artemidoros, a loin of the same sacrificial animal because of his piety and devotion.[8]

The research that made it possible to learn about the temple and the inscription, the translation of which is presented above, was conducted quite a long time ago, but the finds still intrigue. The construction of the temple itself and the data or information gleaned from reading the text found inside the temple both merit attention.

The temple architecture and its vicinity

Schmidt, von Haller, and Downay have accurately identified and interpreted the main elements of the sacred building.[9] However, we must consider whether it is possible to go beyond identifying elements omitted by previous researchers and determine how the Temple of Gareus was situated within the urban space, what it might have looked like in the urban layout, and whether it dominated the spatial arrangement of this part of the city. This is a challenging task, because archaeological works have been conducted only in the immediate vicinity of the temple, focusing mainly on uncovering the remains of the sacred building. Consequently, the only available information is derived from the report. The discovery of several residential houses in the vicinity of the Gareus structure proves that the temple was planned and built in an already urbanised space. The topography of the surrounding area clearly shows signs of intense development. The land to the north and west of the temple is clearly raised relative to the terrain around it. This indicates the presence of residential buildings in the area, which, like the temple itself, have been well-preserved. This proves that the residential quarter was built at the same time and that the buildings were maintained well. The temple is far removed from the main *tell*, implying strongly that it was separated from the administrative and religious quarter situated there. Given the size of this part of the town and the proportion of land occupied by the temple compared to the rest of the 'district', it was undoubtedly the only impressive religious building in the entire urban complex. The Temple of Gareus stood out as the dominant and most magnificent element in the landscape of that part of Uruk during the Parthian Period. The temple's entrance, set within a *temenos* that evokes a fortified wall, was located in its eastern section. As no elements of it have survived, one can only surmise that it must have been, if not monumental in character, then certainly visually distinctive from the series of pilasters imitating the shapely defensive towers. The temple courtyard was entered through a gate, or *propyleia*. However, most people could only enjoy the view from the street running along the *temenos* wall. Passers-by and visitors to the temple would have seen a decorative colonnade upon crossing the thresholds of the *temenos*. This colonnade was probably much wider than the façade of the sacred building itself. The modest temple, hidden behind a colonnade imitating the layout of the temple in the *hexastylos prostylos* order, looked much more imposing from the perspective of the *propyleia*. This effect was achieved by aligning the columns so that, looking from the entrance to the temple, the second column from the left and the second column from the right were perfectly in line with

[7] Maier 1960.

[8] I would like to sincerely thank Professor Adam Łajtar for helping me to fully understand the quoted text.

[9] Schmidt 1970; Downey 1988; Kose 1998.

the corner of the temple. The distortion of perspective created by these columns, as seen from the preserved lower parts, is remarkable, as it makes the temple appear more monumental than it actually is.

The location of the temple within the city and its presumed importance to the local population render the inscription an important source – it reveals much about the inhabitants of the district at the foot of the main tell at Uruk. It is difficult to assume that the entire district was settled by the Dollamenoi based on a single reference. However, it is reasonable to assume that people belonging to this group may have lived in the vicinity – if not around the temple itself, then perhaps in the district of which the Temple of Gareus was a part.

Discussion

A separate problem that we are unable to deal with at present is the attempt to guess where these inhabitants may have come from. Only a single ancient reference – the very first lines in Strabo's Book XVI – mentions *Dolomene*, Δολομηνή, as a place near Ninos, or Nineveh (Strabo XVI, 1.1).[10] Assuming this information is reliable, it suggests a possible migration from the north southwards, although the reasons for such a population shift remain uncertain. Despite extensive research, no tribal name or toponym equivalent to Dolomenoi has been found in Assyrian or Aramaic sources. We are, therefore, dealing with a small community, a congregation, or something similar, which escaped the attention of earlier sources because of its modest size. The name itself is clearly of Semitic origin, possibly Akkadian. In Aramaic *d'lamn* can be translated as the adjective 'northern'. The Akkadian dictionary contains two terms that fit well with the Graecised variant of Akkadian words. The first of these is *dalāmu*, which can be translated as 'underworld'. Another word that corresponds better with a human group is *dalāum*, which means to 'praise, sing, glorify' someone, including a god. The latter term denotes a group of worshippers or people who praise a deity, and thus by implication may refer to a congregation, association, or clan of priests from northern Mesopotamia. They may have felt isolated in Uruk, and we can assume they brought traditions, or modes of worship, from their homeland.

The Dollamenoi, or a part of that group, possibly arrived in Uruk from northern Mesopotamia, so it is reasonable to assume that some architectural elements of the Temple of Gareus should be traceable in the north. At the current state of research, it is difficult to find close affinities or even similar sacred structures in northern Mesopotamia. In Nineveh, which still existed during the Parthian Period, there was a temple dedicated to Nabu/Apollo, but its architectural form does not resemble the temple known from Uruk.[11] However, there are three sacred buildings that resemble, or maybe even drew inspiration from, the Temple of Gareus. One is the so-called 'Peripteros of Ashur' (Fig. 6).[12] This temple is different in scale, but the floor plan is very similar. The columns surrounding the temple proper, arranged in what W. Andrae called a *peripteros*, gave the building its monumental character, much like the columns in the façade did in the Temple of Gareus. The other two buildings are located in Hatra. The first is the so-called 'Barmaran Temple', erected on a podium and surrounded by a colonnade, whose most characteristic element is the Syrian arch placed in the *tympanum* (Fig. 7).[13] The 'Shahiru Temple',

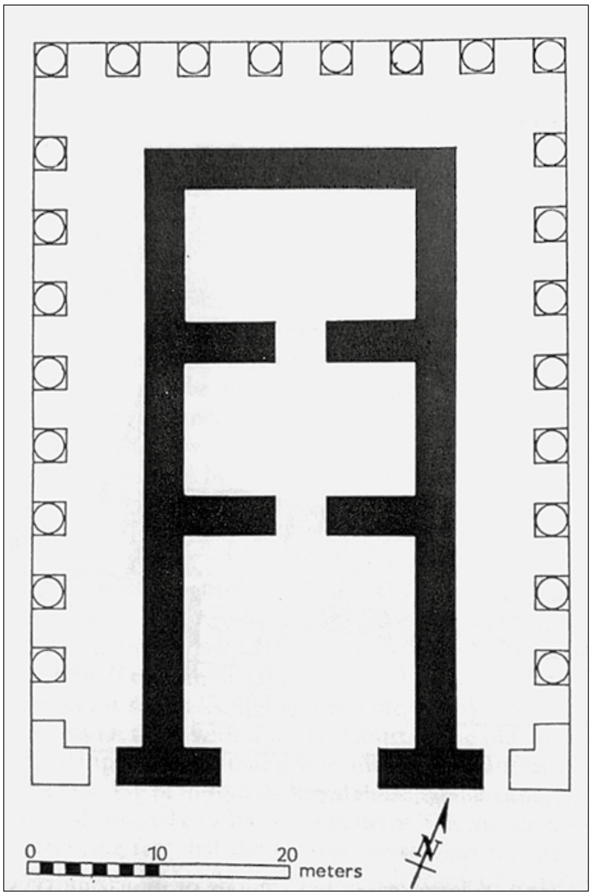

Fig. 6. Ashur, the *peripteros* temple floor plan (after: Andrae 1967, fig. 237).

[10] Oelsner 2014, 305–306; Roller 2018, 885.

[11] Reade 1998.

[12] Andrae, Lenzen 1967, 64–67; Andrae 1977, 258–259.

[13] Safar, Mustafa 1974; Jakubiak 2014, 24–27.

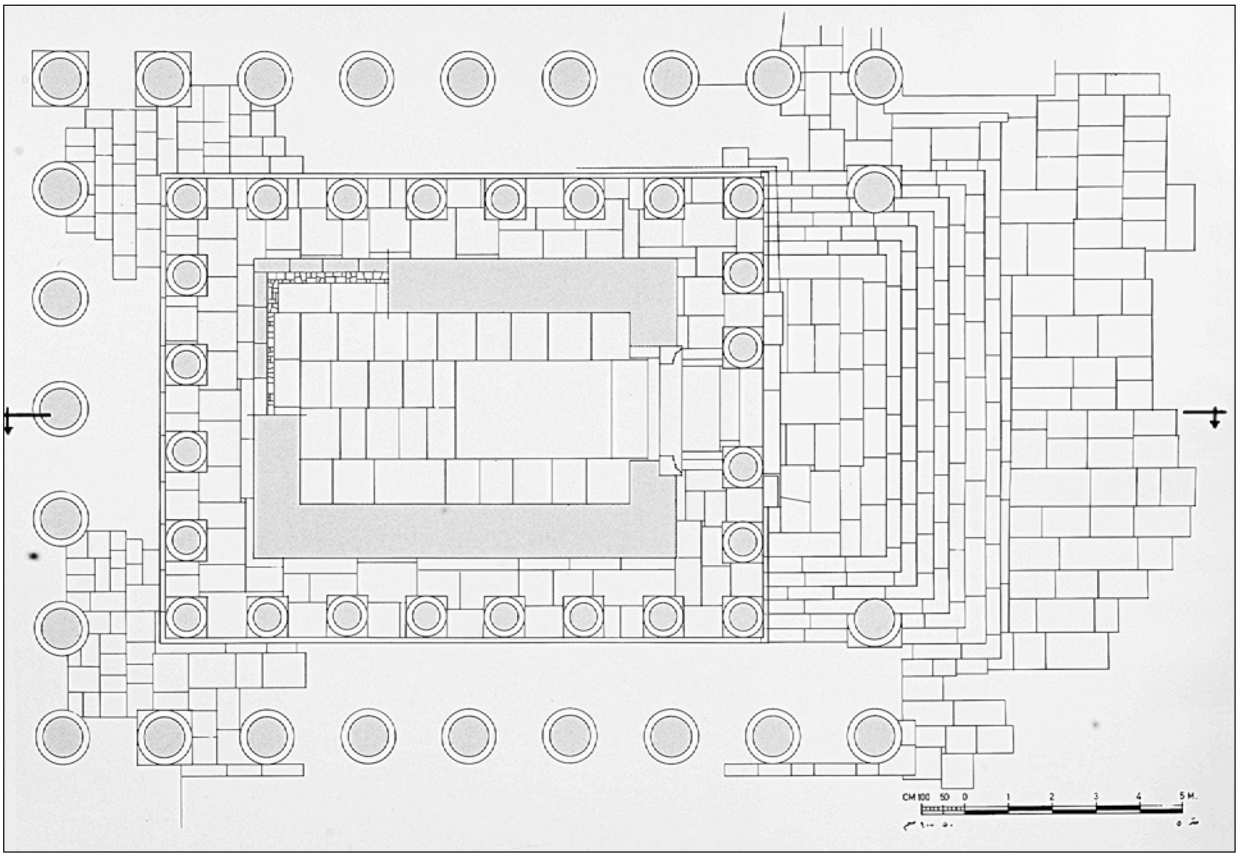

Fig. 7. Hatra, Temple of Barmaran floor plan (after: Safar, Mustafa 1974, fig. 345).

also located within the *temenos*, exemplifies the similarity (Fig. 8).[14] Here, it lies not in the temple plan, but in the decoration of the façade. Just as in Uruk, the columns in front of the Shahiru Temple, or those forming part of its façade, clearly were not structural elements but rather purely decorative.

The above-mentioned inscription also features the name Minnanaios, which merits attention. Unlike the other names in the inscription, it is not Greek. Merkelbach and Stauber have demonstrated it to be a Mesopotamian name, and therefore local.[15] This name contains a theophoric element referring to the name of the Sumerian goddess Nanaya. This goddess has clear traces of worship in Hatra, which corresponds to the place of origin of the Dolamenoi, namely northern Mesopotamia.[16] It is important to note that Nanaya was not the only ancient Mesopotamian deity worshipped in Hatra. The widespread worship of Nergal is also attested there, a deity who, like Nanaya, originated in the Sumerian pantheon.[17] It is clear that across northern Mesopotamia and ancient Assyria elements of the 'primordial' religion, or rather the oldest known from the region to date, survived and remained practiced in Hatra, and probably elsewhere. In short, these places were religious outposts, where an old form of religion became petrified.

The architectural elements discovered during the excavations make it clear that the building was adorned with carved embellishments. The iconography indicates beyond doubt that these were representations of fantastic creatures, commonly seen in Mesopotamian art. In this case, however, the hybrid depicted has a scorpion's tail, a body of a winged lion, and a head of a dragon, which is slightly reminiscent of the Babylonian Mushkushu (Fig. 9).[18] It is often interpreted as a sea dragon, but this is incorrect. Rather, the depiction combines several iconographic elements that link all the components of the world together.

[14] Safar, Mustafa 1974; Jakubiak 2014, 29–30.

[15] Merkelbach, Stauber 2005, 118–119.

[16] Jakubiak 2014.

[17] Jakubiak 2014.

[18] Kose 2013, figs. 57.3, 322.

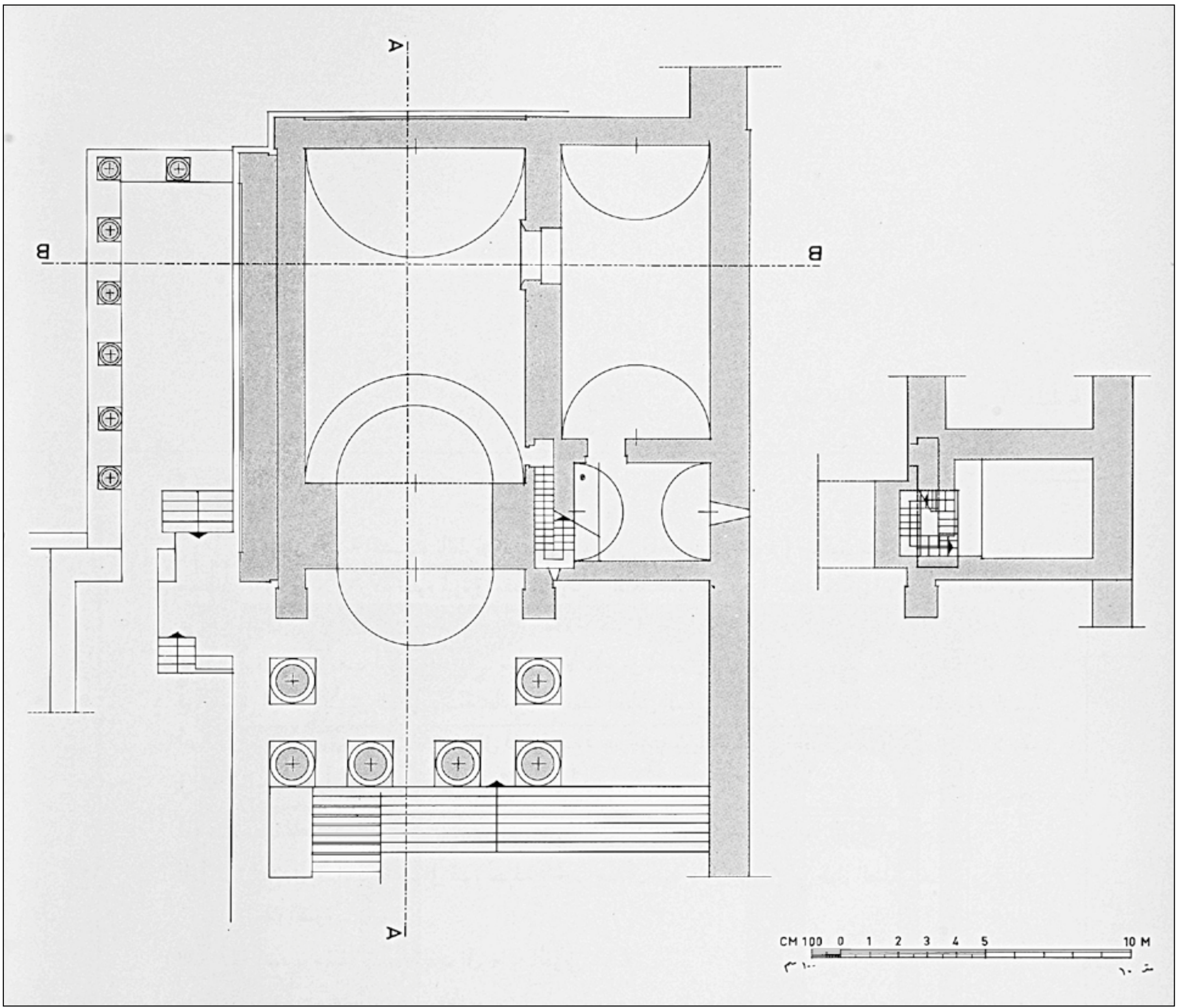

Fig. 8. Hatra, Temple of Shahiru floor plan (after: Safar, Mustafa 1974, fig. 338).

Fig. 9. Uruk, Temple of Gareus, decorated brick form the temple (after: Kose 2013, fig. 57.3).

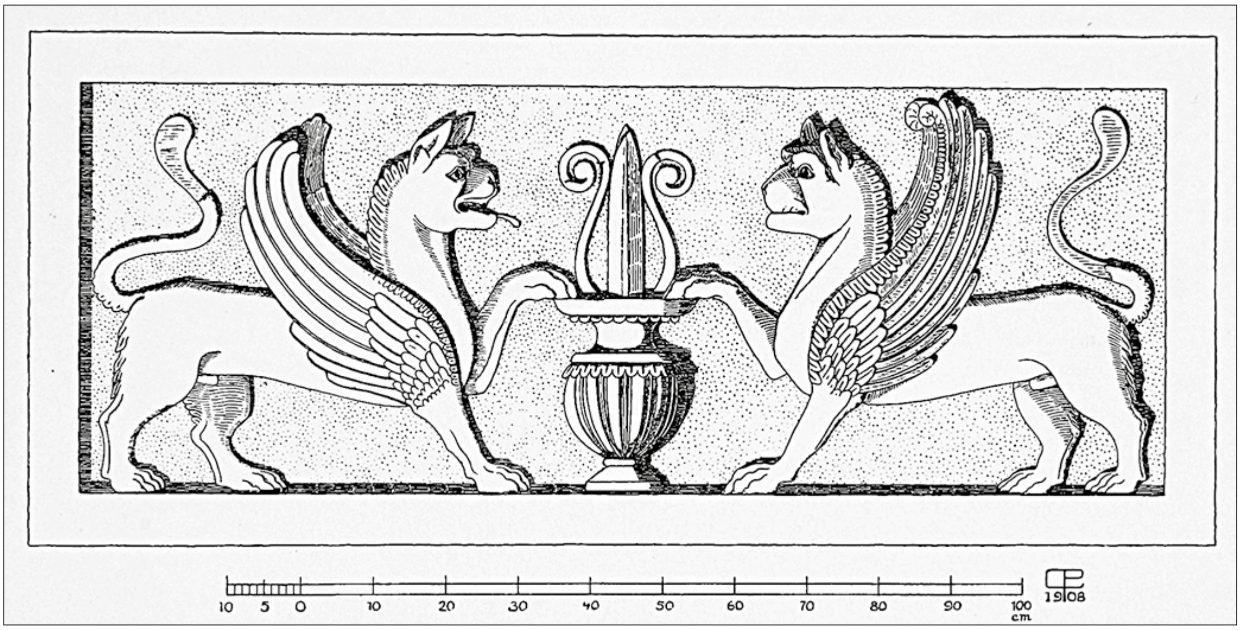

Fig. 10. Hatra, bas relief decoration from Room 10 in the Great Iwans complex (after: Andrae 1912, fig. 251).

The chthonic world is manifested by the scorpion, the lion is identified with the earth, and the wings and the dragon link this animal to the heavens. This symbolism encapsulates the complexity of the world. While the interpretation is therefore correct, one must ask what element may have permeated all these worlds or linked them together to form a single religious amalgam or concept. It is important to note that similar decorations have been found in northern Mesopotamia – three examples are known in total, all belonging to the same category of monuments. Representations similar to those found in the Temple of Gareus were unearthed on stone cornices adorning monumental buildings in Nineveh and Hatra. The artefact found in Nineveh came from the archaeological site of the south-west palace of Kuyundjik.[19] This massive cornice was decorated with fantastic creatures similar to those placed antithetically in front of a vessel resembling a crater. The only difference is that the scorpion's tail there was replaced with a lion's tail. Two further monuments were unearthed at the site of the Great *Iwans*. The first was found in the passage between the *iwan* and the square temple projecting beyond the narrative at the back of the *iwan* complex.[20] This fragmentary surviving cornice is lavish and elaborate, with its most noteworthy feature being a depiction of a griffin, strongly elongated in proportions. The silhouette of the creature is simplified, but despite few formal similarities with the representation from Uruk, it undoubtedly carries a similar meaning and symbolism. The Walter Andrae expedition found a second representation in the northern *iwans*, in the entrance to Room 10 (Fig. 10).[21] This cornice depicts a composition with two griffins facing a crater or vase emitting a kind of stylised flame. This element is crucial, as it is the best-preserved part of the whole composition. It is, therefore, essential to address the key theme arising from the analysis of the Temple of Gareus: Who was worshipped as a god in the southern part of Uruk? Given the elements presented above, it is reasonable to conclude that the name Gareus is a protoplast of Mesopotamian deities and possibly of early origin. Alternatively, the name can be explained through the Akkadian language. The Akkadian dictionary contains the word *girru*, meaning 'fire'. The Sumerian god Girra, known as Girru in the Akkadian variant, likely derives his name from this word.[22] Although regarded as a deity associated with fire, he himself did not embody fire, even when seen as a destroyer, an arsonist, or deity responsible for reed fires. In the Old Babylonian Period, he was identified as a purifier, a bearer of lightning, or even a judge. It is also crucial to note that *Girru* is one of the forty-sixth epithets of Marduk, appearing notably at the end of *Enuma Elish*. Moreover, Girru was believed to reside in Irigal. This suggests that the cult of Gareus, at least in its later form,

[19] Reade 1998, figs. 13, 76.
[20] Dirven 2022, figs. 11, 138.
[21] Andrae 1912, figs. 251, 149.
[22] Frayne, Stuckey 2021, 115–116.

continued a very long-standing tradition of worship rooted in the distant past. Since the god resided in Uruk, in the temple of Irigal, it can logically be assumed that a group of his followers, hailing from northern Mesopotamia, moved south, bringing with them their traditions of sacred architecture and religious expression. This may have been done in an effort to remain close to the god's principal seat. Although we cannot say with certainty whether this was the sole motivation for the Dollomenoi group's settlement in Uruk, the cult of Girru/Gareus evidently survived in northern Mesopotamia, just as the cults of Nanaya and Nergal did. It is likely that the followers of Gareus overcame significant challenges to return to the regions from which their deity originated – the southernmost parts of Mesopotamia and one of its oldest religious centres, which had been continuously active for many centuries, ever since the foundation of the city. This points to a strong sense of religious awareness or, more likely, to elements of the story that still elude us – such as the identity of Gareus himself or his role in the late religious landscape of southern Mesopotamia. Much remains to be discovered.

The creation of the temple was no coincidence. A major religious centre, focused around a massive sanctuary, developed dynamically around the same time in northern Mesopotamia, namely in Hatra. The beginning of this sanctuary's expansion coincided with the creation of the inscription found in the ruins of the Temple of Gareus. Notably, the cult of Gareus is not attested in the north – we must thus consider the aforementioned possibility that members of this congregation came from that region. What we may be witnessing is a relocation of the fire deity's place of worship away from its original location and closer to Irigal. It is also possible that the cult of Girru – known as Gareus in its final phase – was in decline. The Dollomenoi group may have been among the last of his followers, attempting to revive the cult at its birthplace. This could represent the final chapter in the history of the cult of this enigmatic Mesopotamian deity, whose temple stands among the unique religious structures discovered at Uruk. If this interpretation is correct, then the identity of Gareus worshipped there becomes clear: He was a relatively obscure deity. The cult of Gareus is another example of how ancient Mesopotamian beliefs endured in Uruk, a process likely analogous to what occurred in Hatra, where the continued worship of Mesopotamian deities is also attested. The worship of Gareus either remained in the consciousness of the local population or was kept alive by the last followers of Girru/Gareus who migrated from the north. Notably, the migrants settled in Irigal, where their god was believed to have originated from, apparently in order to remain close to the holiest places of their tradition.

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Equestrian Relief From Ptolemais and The Nisean Horse

Abstract

Drawing on the analysis of the proportions of the rider and horse shown on the Hellenistic relief found at the so-called 'House of Leukaktios', Ptolemais, Libya, this study supports the hypothesis that the aforementioned figure depicts a rare breed of exceptionally large horses – the Nisean chargers from the ancient Nisa in the Median Plain. The author argues that the rider shown on the relief performs a *levade*, an equestrian movement described in detail by Xenophon. As only exceptionally large horses were able to perform the *levade* properly, and only the Seleucid dynasty had unrestricted access to such animals, the horse depicted on the relief in question must have arrived in Egypt as a result of a diplomatic contact. The history of relations between the Ptolemaic and Seleucid dynasties suggests that it would have occurred when the future Egyptian king, Ptolemy VIII Euergetes II, governed Cyrenaica. If this was the case, the Ptolemais relief would have been sculpted before 145 BC.

Keywords: Nisean horses, Ptolemais relief, *levade*, Greek sculptures, Ptolemy VIII Euergetes II

In 2002, during excavations carried out by the Archaeological Mission of the University of Warsaw in Ptolemais, Cyrenaica (Libya), a limestone relief depicting a rider seated on a rearing horse was unearthed (Fig. 1). It was found inside the so-called 'House of Leukaktios', a villa from the Roman times. Even though the construction phase to which the monument belonged can be dated to before AD 262 – when an earthquake caused the collapse of some structures – it was sculpted earlier in the Hellenistic Period.[1] According to the publishers of the monument, the style of the representation is reminiscent of some earlier Attic works. The pose of the horseman riding the rearing horse resembles the well-known Athenian stela of Dexileos from Kerameikos.[2] However, the Athenian monument shows a warrior riding down a fallen foe.[3] On the contrary, the relief from Ptolemais was not intended to be a victory monument. Instead, the main figure, a mounted hero, was shown on the rearing horse standing before a young boy and a woman.[4] The monument in question belongs to the broad category of 'heros equitans', representations widespread in the eastern Mediterranean and western Pontic region in the Hellenistic and Roman times, especially in Thracia and Dacia.[5] The closest analogies come from Cyrenaica itself[6] and are well understood, similarly to the votive character of the monument.[7] The aim of the present paper is to focus on an important and overlooked aspect: the horse portrayed on the relief is exceptionally tall and quite stocky, while the rider appears to be of short stature. None of the horse representations from the region depicts that particular animal in such a manner.[8] Moreover, the Roman author Aelian considered Libyan horses to

[1] Mikocki, Muszyńska-Mikocka 2009, 177–178.

[2] Mikocki, Muszyńska-Mikocka 2009, 180.

[3] Grave relief of Dexileos, son of Lysanias of Thorikos (ca. 390 BC), Kerameikos Museum, Athens (see Knigge 1991, 169, fig. 3a). The rendering of the details of the horse's anatomy are reminiscent of earlier works, like the Parthenon frieze, but the general dynamics of the representation are something new (see Markman 1969, 100).

[4] Mikocki, Muszyńska-Mikocka 2009, 180.

[5] Junkelmann 1990, 243–244; Mikocki, Muszyńska-Mikocka 2009, 180; Nemeti, Nemeti 2014, 241–242.

[6] Pandolfi 1998, 449–455; Mikocki, Muszyńska-Mikocka 2009, 182–184.

[7] Mikocki, Muszyńska-Mikocka 2009, 181–184.

[8] Mikocki, Muszyńska-Mikocka 2009, 180–184; Abdelhamed 2023, figs. 1, 5.

Fig. 1. Horseman from the Ptolemais relief (drawing by R. A. Gawroński, after: Mikocki, Muszyńska-Mikocka 2009, fig. 2).

be rather slim.[9] Therefore, one can hypothesise that the anonymous sculptor of the relief in question based his work on a real model and wanted to do justice to an exceptional and rare breed, likely imported from abroad. It should be emphasised that the sculpted horse was shown performing a special kind of equestrian evolution, difficult to achieve for an animal of a more slender built.

The issue should be addressed in detail: the depicted animal is shown performing a *levade*. According to the masters of Classical Dressage, *levade* is one of the "figures in the air" or "*Les airs relevés*" – using the convention introduced by the equerry of King Louis XV of France, *monsieur* François Robichon de La Guérinière.[10] It can be described as a move during which the horse raises and draws in its forelegs standing in equilibrium on its bent hind legs. *Levade* was known to the ancient Greeks. The well-known bronze statuette of Alexander the Great retrieved from the famous Villa of the Papyri in Herculaneum depicts the Macedonian conqueror riding a horse, presumably Bucephalus, in such a pose.[11]

The historian and military leader Xenophon described the *levade* in detail: "The opinion sometimes held, that a horse with free leg action will be able to lift its body too, is incorrect. Rather one with loins supple and short and strong (meaning not the part under the tail, but that between the ribs and the haunches, along the flank) will be able to bring his hindlegs further forward under him. And so, when he brings them under him, pull him up with the bit. He will then bend his legs with his hocks and lift his forehand, so that those in front of him will see his front and sexual parts. And when he does this you must give him rein, so that to the beholders he may appear to be doing of his own free will the finest actions proper to a horse".[12] Exactly that phase of the performed figure, with reins held loose is recognisable on the monument from Ptolemais (Fig. 1). It is evident that the anonymous Greek sculptor wanted to represent a horsemanship exercise.

As it was said, the horse shown on the relief from Ptolemais seems to be exceptionally tall and quite stocky while the rider appears to be of short stature, resulting in proportions contradictory to the earlier Greek artistic tradition. Hellenic artists preferred showing lighter animals of slender conformation, as the famous bronze sculpture of 'Artemision Jockey' exemplifies.[13] At the same time, the depicted riders were far more important and thus larger than horses. The sculptures from the Great Panathenaic Parthenon frieze are a good example of this convention: the horses shown on the frieze (Fig. 2) are too small in relation to their riders.[14] Indeed, the sculptors of that work had depicted a horse that "was warm-blooded, smallheaded, and fine-boned, although its small stature when compared with the frieze's riders

[9] Aelian, *De natura animalium* 3, 2: "*graciles quoque nec corpulentos* – slim and not stocky" (author's translation). See also Abdelhamed 2023.

[10] de La Guérinière 1742, 129–136.

[11] However, we should bear in mind that the hind legs of the statuette and the left (rein) hand had been restored after the discovery (see Mattusch 2008, 250–251) for an accurate image and description. Nonetheless, judging from the rest of the work, it is safe to assume that showing the *levade* was the intention of the anonymous Greek sculptor.

[12] Xenophon, *De equis aiendis* 11. 2-3: "οὐ μέντοι ὅ γε οἴονταί τινες τὸν τὰ σκέλη ὑγρὰ ἔχοντα καὶ τὸ σῶμα αἴρειν δυνήσεσθαι, οὕτως ἔχει: ἀλλὰ μᾶλλον ὃς ἂν τὴν ὀσφῦν ὑγράν τε καὶ βραχεῖαν καὶ ἰσχυρὰν ἔχῃ (καὶ οὐ τὴν κατ᾽ οὐρὰν λέγομεν, ἀλλ᾽ ᾗ πέφυκε μεταξὺ τῶν πλευρῶν καὶ τῶν ἰσχίων κατὰ τὸν κενεῶνα), οὗτος δυνήσεται πόρρω ὑποτιθέναι τὰ ὀπίσθια σκέλη ὑπὸ τὰ ἐμπρόσθια. ἢν οὖν τις ὑποτιθέντος αὐτοῦ ἀνακρούῃ τῷ χαλινῷ, ὀκλάζει μὲν τὰ ὀπίσθια ἐν τοῖς ἀστραγάλοις, αἴρει δὲ τὸ πρόσθεν σῶμα, ὥστε τοῖς ἐξ ἐναντίας φαίνεσθαι τὴν γαστέρα καὶ τὰ αἰδοῖα. δεῖ δὲ καὶ ὅταν ταῦτα ποιῇ διδόναι αὐτῷ τὸν χαλινόν, ὅπως τὰ κάλλιστα ἵππου ἑκόντα ποιῆσαι δοκῇ τοῖς ὁρῶσιν" – trans. E. C. Marchant (1920), quoted after Anderson (1961, 123).

[13] Hemingway 2004, 49–53, see esp. figs. 32–33. However, in the case of the Jockey of Artemision, there are some minor stylistic problems: the sculptor rendered the hind legs longer and shortened the front ones.

[14] Ridgway 1981, 83.

Fig. 2. Horseman from the Parthenon freeze, British Museum, London (drawing by R. A. Gawroński, after: https://en.wikipedia.org/wiki/File:Cavalcade_west_frieze_Parthenon_BM.jpg – access 31.12.2024).

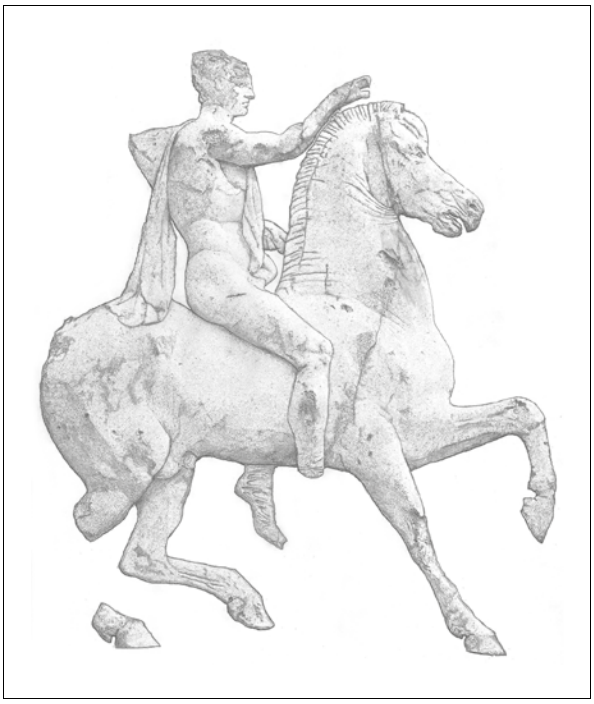

Fig. 3. Horseman from the marble relief, Metropolitan Museum of Art, New York (drawing by R. A. Gawroński, after: https://www.metmuseum.org/art/collection/search/247989 – access 31.12.2024)

may be due to artistic license".[15] For example, the animals sculpted on the mounting scene are not taller than their rider's belts,[16] which is highly unlikely to happen in real life, even though ancient Greek horses were quite small.[17] Also a late Classical or early Hellenistic marble relief, now on display at Metropolitan Museum of Art, New York, shows a relatively tall horseman riding a rather small mount (Fig. 3).[18] Therefore, one may hypothesize that the sculptor of the Ptolemais monument wanted to represent an exceptionally large and strong horse.

At this point, the present knowledge about the *levade*'s biomechanics becomes informative. According to modern research, only horses with strong muscles and well-developed hind legs can perform the *levade* correctly, since the horse raises his trunk from 16 degrees angle to about 36 degrees and remains in that position for 1 or 2 seconds. During the raising phase, the front limb force works in the upward and backward direction, as the animal retracts its front legs to the *levade* position. Simultaneously, the animal uses the muscles of its back and hindquarters to raise its forehand, rather than using the front limbs to push the forehand upward.[19] Not surprisingly, "horses that perform a correct *levade* are few".[20] The same may have been true also in Antiquity – horses capable of performing the *levade* must have been rare.

Moreover, contemporaneous Ptolemaic iconography indicates that the elite Macedonian, Thracian, and Greek horsemen used rather slender mounts. And so, some of the painted funerary limestone slabs preserved at the Ptolemaic capital, Alexandria,[21] roughly dated to the 4th or 3rd century BC, depict horses. Obviously, the quality of the surviving evidence precludes categorical statements and there is a lot of artistic license involved, but some phenotypic features of the depicted animals can easily be recognised. For example, the funerary slab of Pelopides, the Thessalian, said to be found in 1884 in a tomb near Alexandria and now kept at the Metropolitan Museum of Art, New York, shows a relatively tall and slender horse tamed by a man dressed in a pale yellow chiton.[22]

[15] White 2011, 26.

[16] Jenkins 2006, 98, fig. 87.

[17] The bone remains recovered from a Hellenistic tolos grave discovered near Pylos in Peloponnese show that ancient Greek horses stood some 137–155 cm at the withers (see Junkelmann 1990, 250). An average Greek male from the period in question was about 170–171 cm tall (see Kron 2005, 72).

[18] Richter 1954, 80 and pl. CIV, fig. 142. Richter suggests a late 4th-century chronology for the New York relief.

[19] Clayton 2003, 15.

[20] Clayton 2003, 14.

[21] Cole 2019, 1.

[22] Cole 2019, 2–3, fig. 1.

Fig. 4. Massive Scythian horse in the relief from Apadana, Persepolis (drawing by R. A. Gawroński, after: Head, Scollins 1992, 46, fig. 32c).

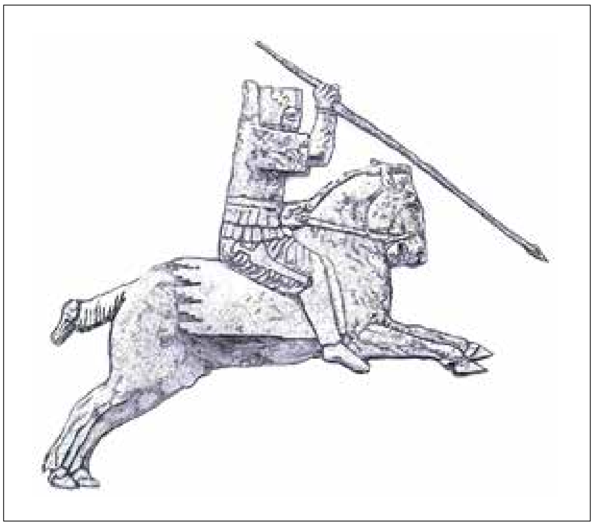

Fig. 5. Achaemenid horseman in the relief found at the Altıkulaç village, Turkey (drawing by R. A. Gawroński, after: https://en.wikipedia.org/wiki/Alt%C4%B1kula%C3%A7_Sarcophagus#/media/File:Alt%C4%B1kula%C3%A7_Sarcophagus_Combat_scene_(detail).jpg – access 31.12.2024).

Another limestone slab, said to come from the Hadra cemetery and now kept at the Graeco-Roman Museum, Alexandria, shows a rider mounted on a rather slender horse.[23] It appears that this particular artistic convention was common in Ptolemaic Alexandria. Both the funerary stela of an unknown Macedonian cavalryman, now on display at the Graeco-Roman Museum,[24] and the paintings from Moustapha Kamel Tomb I can be cited as further examples of such practice.[25] In that respect the relief from Ptolemais should be treated as something unusual. The horse shown on the monument seems to be too massive and too large for the Hellenic aesthetic taste. The only analogous depictions of massive horses in the Ptolemaic art are the numerous terracotta representations of mounted Harpocrates, but there the proportions are a consequence of the material used.[26]

There are two possible explanations for such a situation. First, the sculptor of the Ptolemais relief could have made a mistake while calculating the proportions of the intended figures and thus 'spoiled' the final effect. Second, he could have drawn on earlier traditions or on some reality that differed from that of the Greeks. Interestingly, such artistic manner was widespread among the Greeks' sworn enemies – in the conquered Persian Empire. Even a short glance at the Apadana reliefs from Persepolis reveals the fact that the representations of massive and muscular horses are predominant in the Achaemenid art (Fig. 4). Moreover, some of these animals were intentionally sculpted so as to look much larger than tribute horses brought to Persepolis by various subject nations: "They are the famous 'Great Nisean' horses, said by Classical writers to have been bred on the Median plain. They are depicted as long-bodied and ram-headed, with thick necks and heavy crests, and were the primary mounts of elite Persian horsemen".[27] Indeed, that particular feature, i.e. the great size of Nisean horses, is also confirmed by written accounts. Herodotus, while describing the marching order of Xerxes's invading army, made the following statement: "Next [came] ten of the sacred horses called Nisaean, all daintily caparisoned. (Now these horses are called Nisaean, because they come from the Nisaean plain, a vast flat in Media, producing horses of unusual size".[28] Such a huge horse in a combat scene (Fig. 5) is clearly visible on the Achaemenid

[23] Cole 2019, 4–6, figs. 2–4.

[24] Cole 2019, 6–8, figs. 5–6.

[25] Sekunda 1995, 75–76 and figs. 108–110; Cole 2019, 9–10, figs. 8–9.

[26] See, for example, Sekunda, McBride 1995, 63, fig. 106, 75; Bailey 2008, 35, cat. no. 3068, pl. 12.

[27] Curtis, Tallis 2005, 211; Head, Scollins 1992, 46, fig. 32c.

[28] Herodotus, *Historiae* 7.40. 2–3: "μετὰ δὲ ἱροὶ Νησαῖοι καλεόμενοι ἵπποι δέκα κεκοσμημένοι ὡς κάλλιστα. Νησαῖοι δὲ καλέονται ἵπποι ἐπὶ τοῦδε: ἔστι πεδίον μέγα τῆς Μηδικῆς τῷ οὔνομα ἐστὶ Νήσαιον: τοὺς ὦν δὴ ἵππους τοὺς μεγάλους φέρει τὸ πεδίον τοῦτο" – translation after G. A. Rawlinson (1862, 33).

sarcophagus found at the Altıkulaç village located 10 km to the north-east to the town of Çan, Turkey.[29]

It should be emphasised that the sculptor of the Ptolemais relief did not draw directly on Achaemenid artistic traditions. Most probably, he had limited access to old Persian art. Instead, we may suspect that he wanted to show a particular breed – he intended to create an accurate image of the heavy Nisean horse.

However, there is another clue: in Ptolemaic Egypt, Nisean chargers would have been a rare sight. It is not a coincidence that such horses were bred to fulfil the needs of heavy Achaemenid cavalry. The use of heavy armour required heavier and bigger mounts. The abundance of such tall animals was possible thanks to the improvements in horse breeding and the presence of rich pasturelands. One may suspect that access to taller and faster horses was an exclusive prerogative of the Persian state, presumably determined to protect the genetic pool at all costs. Indeed, in the Classical times no other state had the ability to field such heavily-armoured horsemen. As the famous Nisean chargers were specially created and bred for that kind of service, over time they would even increase in size and stature. According to one Chinese source, some of these famous Persian horses, or more precisely their later Parthian descendants, could reach up to 160 cm at the withers.[30] Nonetheless, the Persian supremacy in horse breeding collapsed after the conquests of Alexander the Great. In the Hellenistic times, these animals would have been available to armies of Macedonian successor states, as they became spoils of war. This adds weight to the hypothesis that the Ptolemais relief portrayed one of the descendants of these animals.

If the above hypothesis is true, then one of these mighty horses could have been transported to Egypt. Moreover, such an animal may have been used and ridden at Cyrenaica and then served as a model for the anonymous sculptor. The problematic detail, however, is that the surviving accounts attest to the presence of Nisean horses exclusively in the Seleucid armies. According to Polybios, when Antiochus IV Epiphanes tried to imitate and oust the splendour of the Roman triumph in 166 BC, in particular the celebration of Emilius Paulus's victory at the Battle of Pydna, he organised a military parade at Daphne – which was a suburb of Antioch and a sacred grove dedicated to Apollo. During the parade, following the other prestigious units: "τούτων κατόπιν ἦσαν ἱππεῖς Νισαῖοι μὲν χίλιοι – next came a thousand Nisaean cavalry".[31] It is noteworthy that even in the Seleucid army – which was still considered a mighty force despite the disaster at Magnesia – only a thousand horsemen could have been mounted on valuable Nisean chargers. The Seleucid monopoly can be easily explained – they still had some access to the Median Plain. We should also bear in mind that the bitter rivalry between the Seleucid and the Ptolemaic dynasties could have made the export of valuable horses nearly impossible. Especially since the aforementioned animals were bred specifically for military use. Therefore, in Egypt, not to mention the more distant Cyrenaica, access to such mounts may have been very limited.

However, there is another possibility. At the beginning of the year 193 BC, the Egyptian monarch, Ptolemy V Epiphanes, married the Seleucid princess Cleopatra, the daughter of Antiochus III. They had two sons: Ptolemy VI Philometor and Ptolemy VIII Euergetes II. Around 163 BC, after a dynastic struggle and a Roman diplomatic intervention, Euergetes was banned to Cyrene, where he reigned until his accession to the Egyptian throne in 145 BC. Despite conflicts with the Seleucids, such as the Sixth Syrian War, the sons of the first Cleopatra maintained close ties with the rulers of Antioch as relatives. If a certain amount of speculation is allowed, one may hypothesise that the relief in question could have been created before 145 BC, when Ptolemy VIII Euergetes II ruled Cyrene. Therefore, the horse which served as a model for the Ptolemais relief could have ended up in Cyrene as a diplomatic gift around that time.

We should bear in mind that the Egyptian Ptolemies had shown special interest in obtaining rare animals through diplomatic contacts. According to the poet Lucian, King Ptolemy I Soter paraded a black Bactrian camel before his subjects.[32] The Greek geographer Strabo writes about the first Ptolemy's passion for study.[33] Judging from the titles of works credited to his tutor, Strato of Lampsakos, the king had shown a keen interest in zoology.[34]

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[29] Rose 2014, 136. See also, Shepherd 2012, 57 for an accurate image.

[30] See Hyland 1996, 18, 172, n. 4, where reference is made to a testimony from *Yang K'uan-Chun-Kuo Li-Tai Ch'in-yu-Kao* (A Study of the History of Measures). The reference is quoted after Creel 1965, 647–72. Yet, it is quite difficult to verify the reliability of that information, as all "western" horses were obviously described as much bigger in comparison to the smaller Chinese ponies, see Creel 1965, 655–656: "The horses of distant land, usually to the West or North, and even of their nomadic enemies near at hand [were] quite frankly, superior". Moreover, recent research shows that even the late medieval *destriers*, according to the measurements taken at the Royal Armoury, Leeds, had little more than 15 hh at the withers (approx. 150 cm), see Hyland 1998, 9–10. Therefore, the 160 cm mentioned by the Chinese source seems to be an exaggeration, as even the use of heavy late medieval armour did not require war-horses of this stature.

[31] Polybios, *Historiae* 30. 25. 6.

[32] Lucian, *Prometheus* 4.

[33] Strabo, Geography 17. 1. 5.

[34] Thomas 2021, 30.

His successor, Ptolemy II Philadelphos, had a similar interest in rare animals. According to philosopher and antiquarian Atheneus, who draws on earlier accounts – including that of the 2nd-century historian, Kallixeinos of Rhodes – on one occasion panthers, ostriches and other rare animals were paraded through the streets of Alexandria in a clear imitation of the triumph of Dionysius. The horse-drawn chariots and wild horses were also seen during these processions.[35] It is noteworthy that obtaining all such rare animals required a network of diplomatic connections.[36] Moreover, access to exceptionally large animals had strategic significance and was considered important.[37]

One may argue that the Nisean horses were nothing special in comparison to panthers and ostriches. However, for someone interested in advanced horsemanship the very possession of such an animal offered new possibilities – one of which was mastering the skill of the *levade*. Certainly, one could consider the Nisean charger a valuable and prestigious property. The animal was also a curiosity and the Ptolemies had a long tradition of collecting zoological curiosities – we should remember that horses strong enough to perform the proper *levade* are as rare in our times as they were in Antiquity. At this point, we should note that the monument in question depicts the rider holding the rein loosely, which is congruent with Xenophon's description. Indeed, the artist wanted to show the animal to be capable of performing the *levade* and captured the final motion of the evolution. One may suspect that the sculptor used some life sketches as models. No doubt, the horse shown on the Ptolemais relief was important enough to be deemed worthy of an artistic representation showcasing one of its abilities.

The history of Seleucid-Ptolemaic relations may suggest that the sculpture could have been created after the marriage of Ptolemy V Epiphanes and Cleopatra I, because the Nisean chargers could have been brought to Egypt on this occasion. Bearing in mind that the sculpting workshop was located somewhere in Cyrene, one may suspect that Ptolemy VIII or one of his courtiers were the inspiration behind the artist's project. If that was the case, the relief would have been made after 163 BC and before 145 BC, that is, prior to Ptolemy VIII Euergetes II's ascension to the Egyptian throne and his departure from Cyrene.

Moreover, further support for such a hypothesis can be cited. The publishers of the Ptolemais relief emphasise that the rider sports a haircut similar to that seen in the famous Louvre portrait of Antiochus III. However, they favour an earlier dating suggesting the 3rd century BC, based on the iconography of earlier rulers, such as the two first Ptolemies, who are also depicted with similar haircuts.[38]

The earlier chronology cannot be excluded, as many Persian settlers remained in Egypt under the Ptolemaic rule. Commonly referred to in various papyri as "Persians",[39] they were subjected to constant Hellenisation. But the horses they possessed during the Achaemenid rule could have left their offspring in Egypt and Cyrenaica. Thus, direct Seleucid-Ptolemaic contacts should not be considered a necessary prerequisite for obtaining Nisean horses. However, we have no direct evidence that testifies to the presence of Nisean horses in Egypt before Alexander the Great. At this point, we can present another argument: the aforementioned testimony of Aelian[40] shows that the local Libyan horses were rather slim. In Antiquity, only the rich and well-watered pasturelands of Media[41] supported reliable breeding of exceptionally large horses. In medieval times, the rulers of England had to import warhorses from Europe, mostly from the Mantua region in Lombardy, as the meagre pasturelands of their homeland failed to support the breeding of larger animals.[42] The problem remained unsolved until the late modern era, when agricultural techniques improved considerably. Similarly, the crusading Kingdom of Jerusalem had to import suitable warhorses from Europe by sea.[43] As a result, one can suspect that breeding large horses was likely impossible in ancient Libya.

Therefore, the scenario described in this article, although speculative, appears more plausible. The Seleucid-Ptolemaic connections, despite the endemic conflicts, remained strong after the diplomatic marriage of Ptolemy V. Horses, especially the prized Nisean chargers, could have been a part of the diplomatic exchange. Therefore, the similarities to the famous portrait

[35] Atheneus, *Deipnosophistae* 5. 200–201.

[36] Thomas 2021, 32.

[37] According to Livy (43.5), in the year 170 BC, Cincibulus, the king of the Transalpine Gauls, angry with the Romans over border disputes, was appeased with a gift of two horses with their harnesses. At the same time, the king's brothers obtained permission from the Senate to purchase and take abroad ten more animals. As can be seen, the Romans tried to maintain a monopoly on taller horses and permission to export them was given as a great favour. The imported stallions undoubtedly improved the quality of the Gallic breeds (see Hyland 1990, 21).

[38] Mikocki, Muszyńska-Mikocka 2009, 184–185.

[39] See, for example, Clarysse 1994, 69–77; McCoskey 2002, 26.

[40] Aelian, *De natura animalium* 3, 2.

[41] Davis 1989, 33. The aforementioned finds from Pylos at the Peloponnese may indicate that Hellenistic horses rarely exceeded 155 cm at the withers, see again Junkelmann 1990, 250.

[42] Davis 1989, 64, 108, 112–113.

[43] Nicolle, Hook 1996, 14.

of Antiochus III, a grandfather of Ptolemy VIII, may suggest a later chronology for the work in question, perhaps the 2nd century.

The general conclusion is that the anonymous sculptor of the Ptolemais relief intended to create an image of the heavy Nisean horse. In all likelihood, he had seen such an animal in reality and worked with the help of some life sketches. The history of the Seleucid-Ptolemaic contacts and the findspot of the Ptolemais relief together suggest that the monument had been sculpted somewhere in Cyrene before Ptolemy VIII Euergetes II ascended to the Egyptian throne.[44] Therefore, the relief in question may be cited as indirect evidence that some prestigious animals were exchanged as diplomatic gifts in the Hellenistic world, even though their military significance could be expected to preclude such use.

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[44] There is also a slight possibility that the sculpting was carried out after the beginning of Ptolemy VIII Euergetes II's reign. If that was the case, the relief in question could have been produced in one of Alexandria's workshops and transported to Ptolemais at a somewhat later date.

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Die Entdeckung einer antiken Bronzefigur des Herakles in Schlesien. Wahrheit oder Fiktion?

Zusammenfassung:

Beim Ordnen der archäologischen Sammlung des einstigen Museums schlesischer Altertümer in Breslau (1859–1899) wurden drei schriftliche Nachrichten über eine bronzene Heraklesfigur gefunden, die wahrscheinlich in Schlesien entdeckt worden war. Zwei dieser Nachrichten waren in Archivdokumenten enthalten, die dritte in einer Veröffentlichung. Nach der Auflösung dieser Sammlung (1898) und ihrer Überführung in das neu gegründete Schlesische Museum für Kunstgewerbe und Altertümer (1899), wurden sie bis zur Schließung des Museums 1943 dort aufbewahrt. Alle Informationen über das heute nicht mehr existierende Fundobjekt stammen also aus schriftlichen Quellen, so dass die Kenntnisse darüber unvollständig sind, was eine korrekte Identifizierung der Figur und eine Bestimmung ihrer Chronologie unmöglich macht. Auf Grundlage der vorhandenen Informationen können die Umstände der Entdeckung nicht rekonstruiert werden, was es wiederum unmöglich macht, weiter zu bestimmen, ob es sich um einen tatsächlich schlesischen oder aber einen „fremden" archäologischen Fund handelt. Vielleicht war es doch nur ein Sammlerobjekt? Wie sich herausstellte, wurde die Figur bisher nicht wissenschaftlich erforscht.

Schlagworte: Schlesien, Museum schlesischer Altertümer, Bronzefigur, Herakles/Herkules, Archiv, Recherche

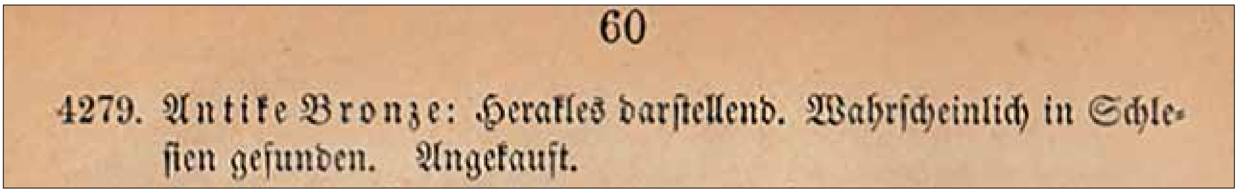
The Discovery of an Ancient Bronze Figurine of Heracles in Silesia. Truth or Fiction?

Abstract:

The archaeological collection of the former Museum of Silesian Antiquities in Wroclaw (1859–1899) contains three written reports about a bronze figurine of Heracles that had probably been discovered in Silesia. Two of these accounts were found in archive documents, the third in a publication. After the dissolution of this collection (1898) and its transfer to the newly-founded Silesian Museum of Decorative Arts and Antiquities (1899), they were kept there until the museum was closed in 1943. Since the find is known only from written sources today, the knowledge about it is incomplete, rendering it impossible to determine its provenance and chronology. Based on the available information, the circumstances of the discovery cannot be reconstructed, which in turn precludes identifying it as a genuine Silesian or a 'foreign' archaeological find. Perhaps it was just a collector's item after all? As it turns out, the figurine has not yet been subjected to a scholarly examination.

Keywords: Silesia, Museum of Silesian Antiquities, bronze figurine, Heracles/Hercules, archive research

Bei der Sichtung von auf Archivalien und Literatur basierenden Informationen zur archäologischen Sammlung des einstigen Museums schlesischer Altertümer in Breslau (1859–1899), stieß der Autor dieses Textes auf drei verschiedene schriftliche Hinweise auf ein und dasselbe Objekt: eine bronzene Heraklesfigur, die



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4279. Antike Bronze: Herakles darstellend. Wahrscheinlich in Schlesien gefunden. Angekauft.

Abb. 1. Information über die Herakles darstellende Bronzefigur im veröffentlichten Verzeichnis der Fundobjekte des Museums schlesischer Altertümer (Verzeichniß 1863, 60; Foto: P. Madera).

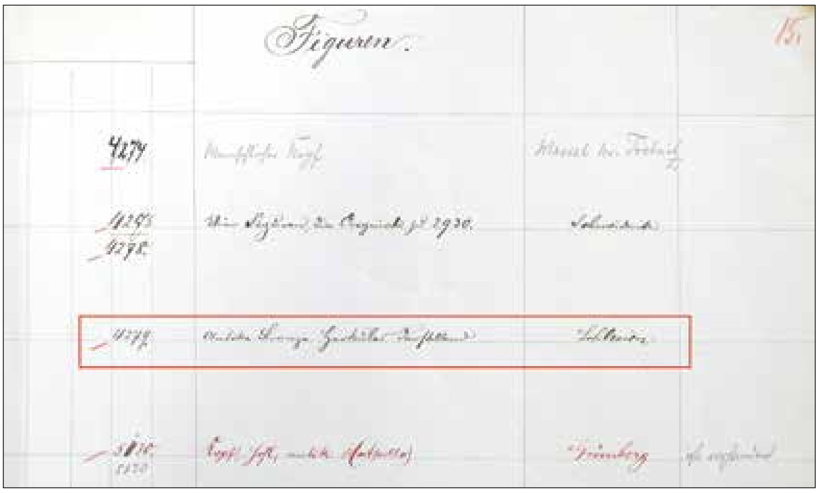

Abb. 2. Information über die Herakles darstellende Bronzefigur im Katalog von J. Zimmermann (MA O.MMW: DzDN-AN, sygn. MA/A/147, p. 15; Foto: P. Madera).

angeblich auf schlesischem Gebiet gefunden worden war. Zwei dieser Nachrichten fanden sich in Dokumenten, die dritte war veröffentlicht. Das Interessante daran ist, dass sie unabhängig voneinander und in verschiedenen Jahren (1863, 1884, 1898) entstanden sind, wobei als erstes die gedruckte Notiz verfasst wurde (1863), und nicht die beiden handschriftlichen (1884, 1898).

Im Jahr 1863 veröffentlichte der Verein für das Museum schlesischer Altertümer ein aktuelles Inventar seines Museums.[1] Darin befanden sich in einer eigenen Abteilung für „Heidnische Altertümer" auch archäologische Objekte (Inv. Nr.: 1–195, 1270–4386). Unter Inv. Nr. 4279 war – als Teil der fortlaufenden Nummerierung (für alle Abteilungen: „A. Heidnische Altertümer"; „B. Kirchliche Altertümer"; „C. Ritterlich=militärische Altertümer"; „D. Bürgerliche Altertümer") – folgende Information abgedruckt[2]: *Antike Bronze: Herakles darstellend. Wahrscheinlich in Schlesien gefunden. Angekauft* (Abb. 1). Es war nunmehr notwendig, diesen Eintrag zu überprüfen – ihn mit den Angaben zu vergleichen, die in den Museumsdokumenten (d. h. Archivalien) vorhanden sein könnten.[3] Im Zuge der Recherche im wissenschaftlichen Archiv des Archäologischen Museums in Wrocław (im Folgenden MA O.MMW: DzDN-AN), das, zumindest im Hinblick auf die Archäologie (Funde, Archive, Büchersammlung) die indirekte Nachfolgeinstitution des Museums schlesischer Altertümer ist[4], wurden zwei Notizen gefunden, die sich direkt auf das besagte Objekt beziehen. Die erste befand sich im Katalog der archäologischen Funde (Band II) von 1884 (MA O.MMW: DzDN-AN, sygn. MA/A/147, p. 15)[5], die zweite in einer Kartei von 1898 (MA O.MMW: DzDN-AN, sygn. MA/

[1] Verzeichniß 1863. An dieser Stelle möchte ich Dr. Robert Heś, dem Leiter des Dokumentenkabinetts des Nationalmuseums in Wrocław, für die Bereitstellung dieser Veröffentlichung danken.
[2] Verzeichniß 1863, 60.
[3] Ausschließlich in den Archivalien des Museums, weil archäologisches Archivmaterial zu Schlesien in den Beständen des Staatsarchivs Wrocław (insbesondere der Bestand der Selbstverwaltungsabteilung der Provinz Schlesien/Wydział Samorządowy Prowincji Śląskiej) nach Orten (Ortsakten) abgelegt ist und das Objekt keinem konkreten Ort zugeordnet werden kann (Margas, Kramarek 1980, 5–18).
[4] Demidziuk 2022, 444.
[5] Dies ist der zweite von fünf Katalogen schlesischer archäologischer Funde der Vorgeschichtlichen Abteilung des Museums schlesischer Altertümer, die von Julius Zimmermann, einem freien Mitarbeiter dieses Museums, zwischen 1872 und 1893 erstellt wurden (Demidziuk 2020, 115–116).

A/394d)[6]. Dabei fand sich im fünften Teil des Katalogs der Bronzeartefakte, welcher ausschließlich Figuren gewidmet ist, folgender Eintrag: *4279 – Antike Bronze Herkules darstellend – Schlesien* (Abb. 2). Dagegen war auf einer der Karteikarten des vierten Teils der Kartei (S–Z), der die schlesischen archäologischen Funde ohne genaue Lokalisierung erfasst (*Schlesisches I Nr. 5*) diese Figur nur mit der Inventarnummer aufgeführt: *4279* (Abb. 3).

Im Ergebnis der Archiv- und Bibliotheksrecherche, die zur Untersuchung dieser drei Hinweise durchgeführt wurde, konnte festgestellt werden, dass das Museum schlesischer Altertümer 1862 von einer anonymen Person eine antike Bronzefigur erworben hat, die Herakles bzw. Herkules darstellt und wahrscheinlich in Schlesien gefunden wurde. Darüber hinaus befand sich dieses Artefakt in der Sammlung der Abteilung für heidnische Altertümer – ab 1873 Vorgeschichtliche Abteilung – bis zur Selbstauflösung dieses Museums im Jahr 1898.[7] Nach der Auflösung dieser privaten Kultureinrichtung[8] gelangte es in die Sammlung des 1899 neu gegründeten städtischen Museums, also des Schlesischen Museums für Kunstgewerbe und Altertümer[9], und hier konkret in die Urgeschichtliche Abteilung. Es ist schwer festzustellen, ob seine museale Wanderschaft dort endete. Möglicherweise wurde die Statuette als antikes Objekt in die 1908 neu gegründete Abteilung „Antikes Kunstgewerbe" überführt, die später (1920) in das „Antikenkabinett" umgewandelt wurde.[10] Diese Möglichkeit besteht zwar, doch wurde diese Art von Einzelfunden – wie hier ein wahrscheinlich antiker (römischer?) Import, der in Schlesien entdeckt wurde – generell in der Abteilung für Urgeschichte aufbewahrt, wie z. B. eine Bronzefigur des Mars, die in Pawlau im Kreis Ratibor (Pawłów w powiecie raciborskim)[11] zum Vorschein gekommen war. Stufte man ein Objekt jedoch nach einer formalen Analyse als modernes Kunstprodukt oder als moderne Kopie ein, wurde es in die Abteilung „Alte Kunstgewerbe" überführt, wie es etwa bei den in Schweidnitz (Świdnica)[12] entdeckten Bronzefiguren der Fall war. Unabhängig davon in welche Abteilung das Objekt gelangt ist, wissen wir, dass es dort im Schlesischen Museum für Kunstgewerbe und Altertümer solange aufbewahrt wurde, bis die Sammlung 1943 evakuiert wurde.[13] Leider ist dem Autor dieses Textes – zumindest zum jetzigen Zeitpunkt der Recherche – das Nachkriegsschicksal dieser Figur nicht bekannt.[14]

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[6] Es handelt sich um eine der Karteikarten des vierten und letzten Teils der 1898 durch das Museum schlesischer Altertümer erstellten Kartei archäologischer Funde (in alphabetischer Reihenfolge der Ortsnamen). Diese Kartei wurde von der Urgeschichtlichen Abteilung des Schlesischen Museums für Kunstgewerbe und Altertümer (1899–1945) weitergeführt und -gepflegt, welche die direkte „Erbin" (der Fundstücke und Archive) der Abteilung für Vorgeschichte des Museums schlesischer Altertümer war (Demidziuk 2010, 206).

[7] Demidziuk 2010, 217.

[8] Łukaszewicz 1998a, 98.

[9] Łukaszewicz 1998b.

[10] Die Lektüre zweier unterschiedlicher Primärpublikationen zu diesem Thema ergab ein negatives Ergebnis. Sowohl im Führer zur archäologischen Dauerausstellung („Raum V: Antiken-Kabinett, Schrank 75 und 76: Antike Metallarbeit") des Schlesischen Museums für Kunstgewerbe und Altertümer (Seger, Masner 1920, 38–39) als auch in einer Studie über die Antikensammlung des Museums (Schmidt 1938) wurde diese Figur nicht erwähnt.

[11] Jahn 1918, 113. Erwähnt in der Kartei der archäologischen Funde der Urgeschichtlichen Abteilung des Schlesischen Museums für Kunstgewerbe- und Altertümer (M–R) – als Fortführung der Kartei der Uorgeschichtlichen Abteilung des Schlesischen Museum für Kunsgewerbe und Altertümer – unter Pawlau (Kreis Ratibor): „375:04 Bronzefigur" (MA O.MMW: DzDN-AN, sygn. MA/A/394c).

[12] Kruse 1819, 117–120, Taf. I: 1–7, 23. In der Kartei der archäologischen Funde der Urgeschichtlichen Abteilung des Schlesischen Museums für Kunstgewerbe und Altertümer (S–Z) – als Fortführung der Kartei der Vorgeschichtlichen Abteilung des Museums schlesischer Altertümer – unter Schweidnitz (Kreis Schweidnitz): „B.b. 54. 55. 61. 64. 65. 66". Mit einer späteren (von 1920?) Anmerkung von Martin Jahn: „moderne Abgüsse der unten aufgeführten antiken Figuren" (MA O.MMW: DzDN-AN, sygn. MA/A/394d). Zuvor waren diese nicht nur in den Archivalien (z. B. MA O.MMW: DzDN-AN, sygn. MA/A/147, p. 15), sondern auch in den Publikationen als antike Funde aufgeführt worden (Kruse 1819, 117–120, Taf. I: 1–7, 23; Drescher 1870, 39; Sadowski 1876, 62; Kalesse 1888, 145; Pescheck 1939, 380; Konik 1959, 193).

[13] Demidziuk 2015, 432. Bereits Anfang 1943 wurde das Museum aus Sicherheitsgründen geschlossen (Łukaszewicz 1998b, 121). Im selben Jahr begann man auch, die Evakuierung der wertvollsten Objekte in mehreren Depots vorzubereiten, sowohl in der Gegend um Breslau (z. B. im Gebäude des Landgerichts) als auch in verschiedenen Orten Schlesiens (z. B. Neukirch [Nowy Kościół], Markt Bohrau [Borów], Namslau [Namysłów], Louisdorf [Łojowice], Neustadt [Prudnik], Heinrichau [Henryków], Klein Bresa [Brzezica], Gröditzberg [Grodziec], Hirschberg [Jelenia Góra], Eichholz [Warmątowice]) (Kramarek 1973, 214).

[14] Es ist selbstverständlich, dass der Autor der vorliegenden Studie vor dem Verfassen des Textes eine Suche nach diesem Objekt in Wrocław durchgeführt hat - im Archäologischen Museum, das die archäologische Sammlung des Schlesischen Museums für Kunstgewerbe und Altertümer übernommen hat (Demidziuk 2022, 445) sowie im Nationalmuseum, in dem sich heute die Kunstsammlung (einschließlich des Kunsthandwerks) dieses einstigen deutschen Museums befindet (Hermansdorfer 1998, 6). Leider waren die Recherchen in diesen Museen ohne Erfolg.

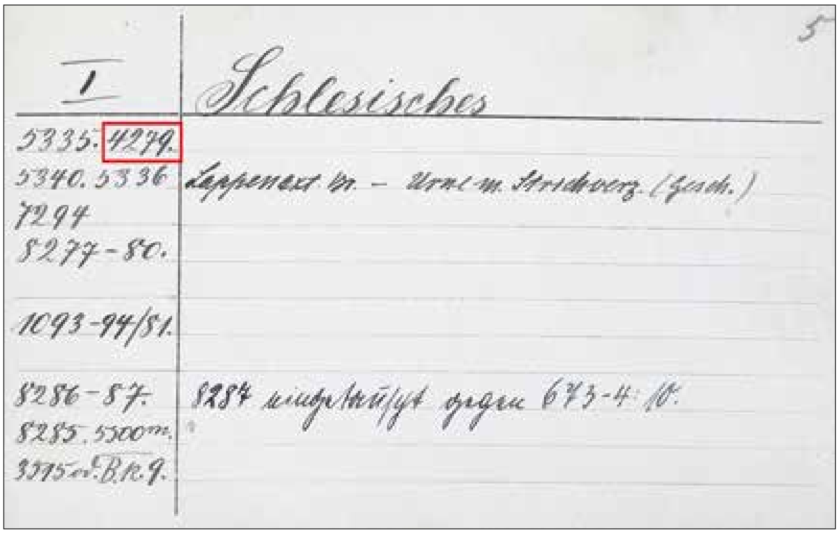

Abb. 3. Information zur Bronzefigur des Herakles bzw. Herkules (hier nur als Inventarnummer 4279) auf einer Karteikarte der archäologischen Fundkartei (S–Z) des Schlesischen Museums für Kunstgewerbe und Altertümer (MA O.MMW: DzDN-AN, sygn. MA/A/394d; Foto: P. Madera).

Vielleicht ist sie, wie die Marsfigur, (unwiederbringlich?)[15] verloren gegangen.

Wie bereits in der Einleitung erwähnt, stammen alle Informationen über diesen angeblich schlesischen Fund nur aus schriftlichen Quellen. Daher ist unser Wissen, zumal ohne jegliche Abbildung (ob als Zeichnung oder Fotografie), unvollständig. Außerdem sind die Angaben sehr spärlich und nur stichwortartig (ohne Beschreibungen oder Maße), was es unmöglich macht, die Figur (Herakles bzw. Herkules?) korrekt zu identifizieren und ihre Chronologie (antik oder modern?) zu bestimmen. Darüber hinaus lassen sich auf dieser Grundlage die Umstände des Erwerbs (und des Auffindens?) nicht rekonstruieren. Dies wiederum macht es unmöglich, weitere Feststellungen – auch grundsätzliche – zu treffen, ob es sich bei diesem Artefakt um einen schlesischen oder einen „fremden" archäologischen Fund handelt[16], oder vielleicht – was sehr wahrscheinlich ist – um nichts anderes als ein (verlorenes?) Sammlerstück.[17]

Es hat den Anschein, dass die Hinweise, die in den Dokumenten und der Literatur zu finden sind, uns lediglich darüber informieren, dass sich eine eventuell in Schlesien entdeckte, bronzene Heraklesfigur vor 1945 in der Breslauer Sammlung befand. Damit wäre dieser Text nichts anderes als ein Beitrag zur Geschichte der Museologie in Wrocław. Die Lektüre der archäologischen Literatur zu diesem Thema zeigt jedoch, dass diese kleine Studie noch etwas mehr sein kann. Wie sich herausstellte, ist diese Figur (bzw. Informationen über sie) nie im wissenschaftlichen Umlauf aufgetaucht[18]. Davon zeugen nicht nur die gedruckten Kataloge der römischen

[15] Obwohl die Kriegsverluste der archäologischen Museumsobjekte Wrocławs bis heute nicht erfasst worden sind (Demidziuk, Żmudziński 2015), wird aufgrund mehrerer statistischer Stichproben davon ausgegangen, dass etwa 60% der Objekte aus der ehemaligen Sammlung (vor 1945) bis heute erhalten geblieben sind (Demidziuk, Kontny 2009, 198). Dies bedeutet jedoch nicht, dass 40% unwiederbringlich verloren gegangen sind. Wie sich herausstellte, haben diverse Objekt lediglich ihren Standort gewechselt. Dafür sind die Nachkriegsschicksale einiger Fundstücke gute Beispiele, wie die Funde aus den „Fürstengräbern" von Sacrau [Zakrzów] (heute im Nationalmuseum in Warschau), das Bronzeschwert ungarischen Typs aus Jägerndorf [Strzelniki] (heute im Oberschlesischen Museum in Bytom), die prachtvolle Bronzespange aus Schweidnitz [Świdnica] (heute im Staatlichen Archäologischen Museum in Warschau) oder die Grabbeigaben aus Noswitz [Nosocice] (heute im Archäologischen Museum der Mittleren Oder in Świdnica). Es ist folglich möglich, wenn auch mit einer geringen Wahrscheinlichkeit, dass die bronzene Heraklesfigur ebenfalls noch vorhanden ist. Dies kann nur durch eine gründliche Suche in verschiedenen Einrichtungen, insbesondere in Museen, zeigen.

[16] Als „fremder" Fund soll hier – im Fall der Breslauer archäologischen Museen (einschließlich der zeitgenössischen) – ein archäologisches Fundstück verstanden werden, das außerhalb Schlesiens (in welchen konkreten historischen oder administrativen Grenzen auch immer) entdeckt wurde (Demidziuk 2021, 212).

[17] Auch diese Möglichkeit muss in Betracht gezogen werden. Dies gilt umso mehr, als damals fast alle schlesischen Residenzen (Burgen, Schlösser, Gutshöfe) über Privatsammlungen verfügten, in denen sich auch archäologische Funde unterschiedlicher Provenienz befanden.

[18] Obwohl Informationen über dieses Objekt veröffentlicht wurden, ist das gedruckte Verzeichnis von Museumsobjekten (Verzeichniß 1863) kaum als strikte wissenschaftliche Veröffentlichung zu betrachten.

Importe[19], sondern auch Publikationen, die ausschließlich antiken Statuen gewidmet sind, die im polnischen Raum[20] sowie im Barbaricum im weitesten Sinne[21] gefunden wurden. Der vorliegende Beitrag stellt also die erste Information zu diesem Fund dar, die in einer wissenschaftlichen (archäologischen) Zeitschrift veröffentlicht wurde. Obwohl das Artefakt physisch nicht vorhanden und womöglich unwiederbringlich verloren ist, wird es durch diese Mitteilung seinen Weg in den wissenschaftlichen Kreislauf finden, auch wenn es sich, besonders mit Blick auf die vermeintlich schlesische Herkunft, um einen zweifelhaften Fund handelt.

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Inland Cargo Vessels at the Mouth of the Oder River from the Early-Modern Times to the Beginning of the 20th Century: An Archaeological Perspective from the Bay of Greifswald

Abstract

This paper focuses on the construction of inland river vessels used at the mouth of the Oder River. As one of the most important communication arteries in Central Europe, the Oder has undergone extensive regulation over the past several centuries. These changes have led to the development of distinct vessel types, designed to navigate both narrow canals and numerous locks, as well as the semi-open waters of the Szczecin Lagoon and Bay of Greifswald. While the general types and distinctive features of these vessels are well-documented in historical and iconographic sources, many construction details and characteristics remain unexplored and poorly understood. Recent marine investment projects in the Bay of Greifswald, however, have enabled the identification and study of several shipwreck sites of river transport vessels dating from the 18th to 20th centuries. These discoveries have provided valuable insights, significantly enhancing our understanding of the design, construction and exploitation of this category of vessels.

Keywords: underwater archaeology, shipwrecks, Bay of Greifswald, inland navigation

Introduction

The construction and exploitation of inland barges have received relatively little attention in maritime history, often overshadowed by the large-scale seafaring. This oversight is partly understandable. Throughout the ages, the presence of bulk-carrying barges on waterways was so ubiquitous that it went almost virtually unnoticed in historical narratives. In the Age of Industrialization, once-prominent and mass-produced 'workhorses' of inland transportation were gradually eclipsed by the expansion of railways, followed by the rise of road transport. In recent years, however, the situation has begun to shift, with growing attention being paid not only to the economic significance of these vessels but also to the regional diversity of their construction, tailored to the unique and specific navigation conditions of individual rivers and canals.[1] This change could not have been possible without a broader shift in the approach to preserving maritime heritage, which increasingly includes artefacts from relatively recent periods.

An example of a region where specific navigational conditions influenced the development of unique vessel designs is the mouth of the Oder River. The peculiar challenges of this area – requiring navigation through the heavily canalized inland waterways of the Oder, transitioning to the wide and partially sheltered waters of the Szczecin Lagoon and the Bay of Greifswald, as well as the open waters Pomeranian Bay – led to the creation of distinctively designed watercraft. These vessels were characterized by unique regional construction features, tailored to meet the diverse and demanding conditions of this complex

[1] E.g. Litwin 2019; Moortel 2011; Ossowski 2010; Reszka 2012; Sohn 2013.

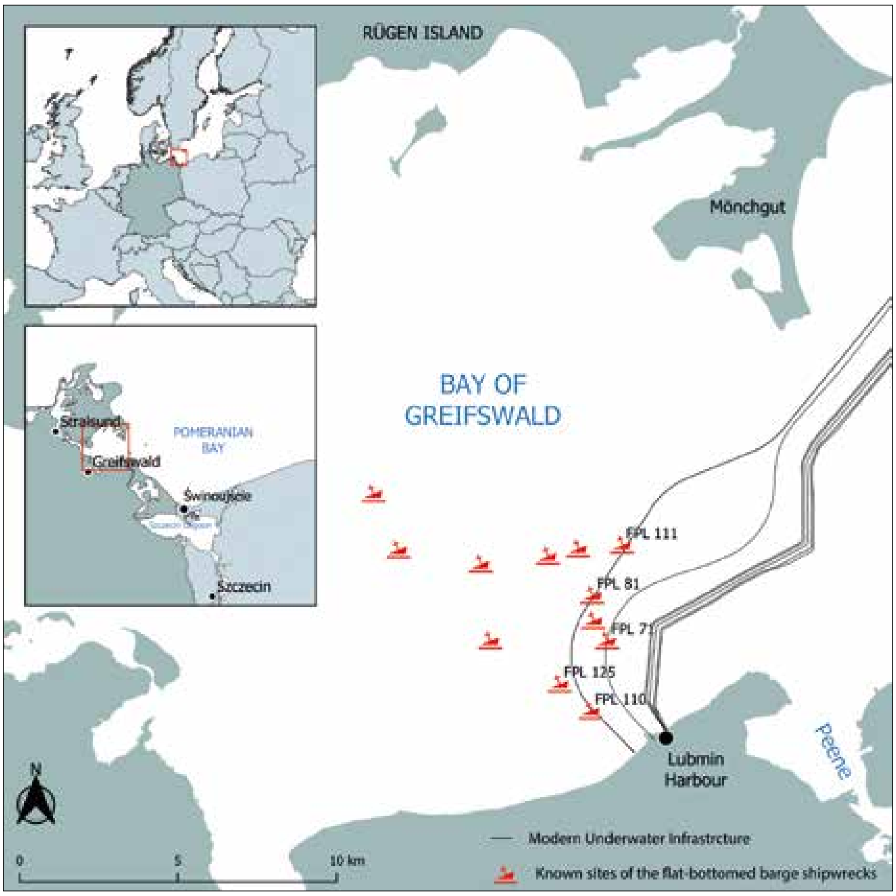

Fig. 1. Location of the shipwreck sites identified as remains of inland and coastal barges within the Bay of Greifswald (compiled by M. Grabowski).

navigational environment – both inland and coastal. The following article focuses on the area of the Bay of Greifswald, where approximately a dozen shipwreck sites have been identified as the remains of the local inland and coastal barges (Fig. 1). Between 2011 and 2019, five of these sites were the focus of archaeological diving operations as part of various offshore and nearshore construction projects.[2] Due to their state of preservation and unique structural features, three of these sites have been selected for a more detailed discussion in the following paper.

The Bay of Greifswald (German: *Greifswalder Bodden*) is a semi-enclosed lagoon in the south-western corner of the Baltic Sea. Bordered to the south and west by the coast of Mecklenburg-Western Pomerania and to the north by the island of Rügen, it has provided favourable conditions for settlement and maritime activity since prehistoric times. Despite its relatively small size, with an area less than 600 km^2, the Bay played a significant role in the regional economy. Here intersected significant communication routes, enabling a vital north-south connection between the rural region of Greater Poland, industrial Silesia, and the Baltic coast with its overseas harbours. Additionally, it facilitated east-west communication among pivotal early-medieval ports-of-trade, such as Ralswiek, Usedom, Menzlin, Wolin and the later Hanseatic harbour towns of Stralsund, Greifswald and Szczecin, along with their immediate economic hinterlands.[3] From medieval times until the mid-19th century, the Bay served as an entrance to the main navigational route of the Oder River. This route extended through the Peene Strait (German: *Peenestrom*) into the Szczecin Lagoon and onward to the harbour of Szczecin, effectively linking the Baltic Sea with the Oder River basin. For centuries, the Peene Strait maintained a significantly deeper and more stable channel compared to the other two straits, Świna and Dziwna, making it less susceptible to sedimentation, meandering and backflows caused by the open waters of the Baltic Sea.

[2] Auer, Grabowski 2017; Grabowski, Auer 2017; Grabowski, Sommer 2019; Sommer 2018.

[3] Gaziński 1993; Hermann 1978; Jöns 2010; Kowalenko 1954; Urliksen 2006.

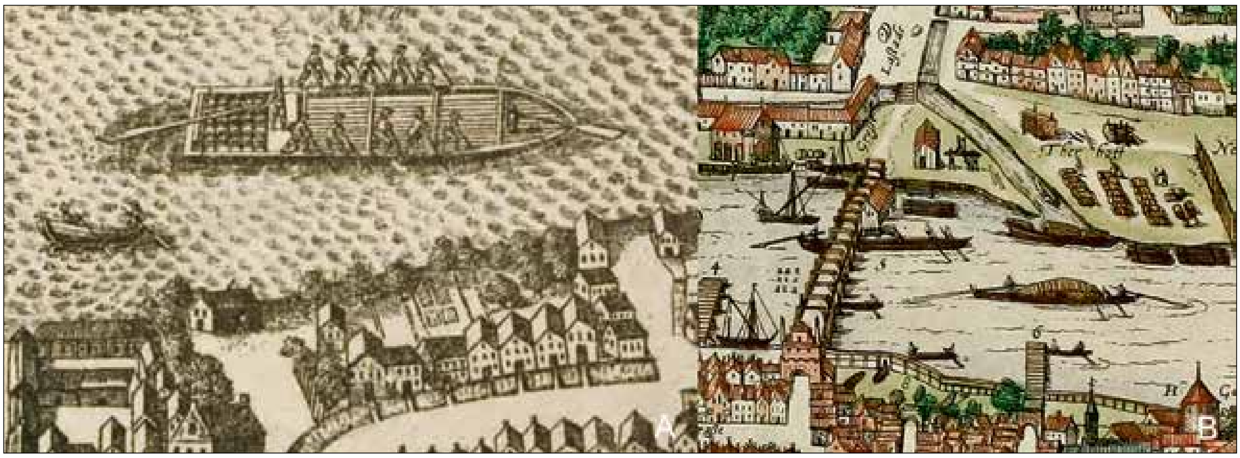

Fig. 2. A – pictorial representation of the Oder vessel, so-called *Schale*, with broad hull and flat, transom aft. Detail of the *Alten Stettin*, created by Heinrich Kote in 1625 (Copyright: Archiwum Państwowe w Szczecinie / signature: PL-65-46-0-357); B – elongated vessels on the Oder River can be associated with the early *Kahn*-type. Detail of the coloured edition of *Alten Stettin* published in *Civitates orbis terrarum,* vol. IV by Georg Braun and Frans Hogenberg, circa 1600 (Public domain).

Inland Navigation in the Pomeranian Region in the Preindustrial Era

Source data on shipping in the estuary of the Oder River before the 18th century is scarce. During the Medieval period, most vessels, including inland crafts, were generally referred to by the broad Latin term *navis* – the ship.[4] Although a few written sources provide examples of various types of ships used on the Oder River, such as those mentioned in the taxation tariff issued by Prince Barnim I for the town of Szczecin in 1278, these documents are often ambiguous and difficult to correlate with other accounts.[5] Contemporary archaeological findings from this era are still limited and are typically associated with relatively small watercraft types, like fishing vessels or coastal traders designed to transport modest quantities of cargo.[6] More evidence of inland ships comes from iconographic representations dating to the 16th and 17th centuries. Among the most commonly depicted are two types: the so-called *Schale*, a broad vessel with a distinctive stempost and transom aft; and a narrow, elongated vessel called *Kahn* (plural *Kähne*), with a characteristic deadrise at both ends of the hull (Fig. 2).[7] The latter, in particular, was destined to play a significant role in the development of Pomeranian seafaring for centuries to come.

At the beginning of the 18th century, the Lower Oder region found itself in an unfavourable geopolitical situation. After the Thirty Years' War (1618–1648), most of the land along the Oder River was incorporated into Brandenburg-Prussia, a predecessor to the Kingdom of Prussia. However, under the terms of the Peace of Westphalia, the northern part of Pomerania, including the river mouth and its main harbour in Szczecin, remained under Swedish control.[8] For the expanding Prussian Empire, a key priority was to gain access to the mineral-rich and resource-abundant region of Silesia. Due to the economic conflict between Sweden and Prussia, the Prussians relied on the Elbe River and its port in Hamburg as their primary route to the open sea. Shipping from the south to the north was directed through the heart of the Prussian Kingdom, passing through Berlin and Hamburg, and further to the North Sea, via canals connecting the upper Oder to the Spree and Elbe Rivers. As a result, the Swedish-controlled part of Pomerania became isolated from its natural southern hinterland and suffered from the high tolls imposed by the Prussian administration.

This situation began to change soon after Szczecin was incorporated into the Kingdom of Prussia in 1720 and the bulk trade on the waterways slowly revived. A breakthrough occurred during the reign of Frederick II 'the Great' von Hohenzollern (1740–1786), an ambitious monarch, who saw the Oder River as the lifeblood of his kingdom and Szczecin as its primary harbour.

[4] Gaziński 1994.
[5] Prümers 1881, 386–387.
[6] Filipowiak 1994.
[7] Ossowski 2010, 132–133.
[8] Rabb 1962.

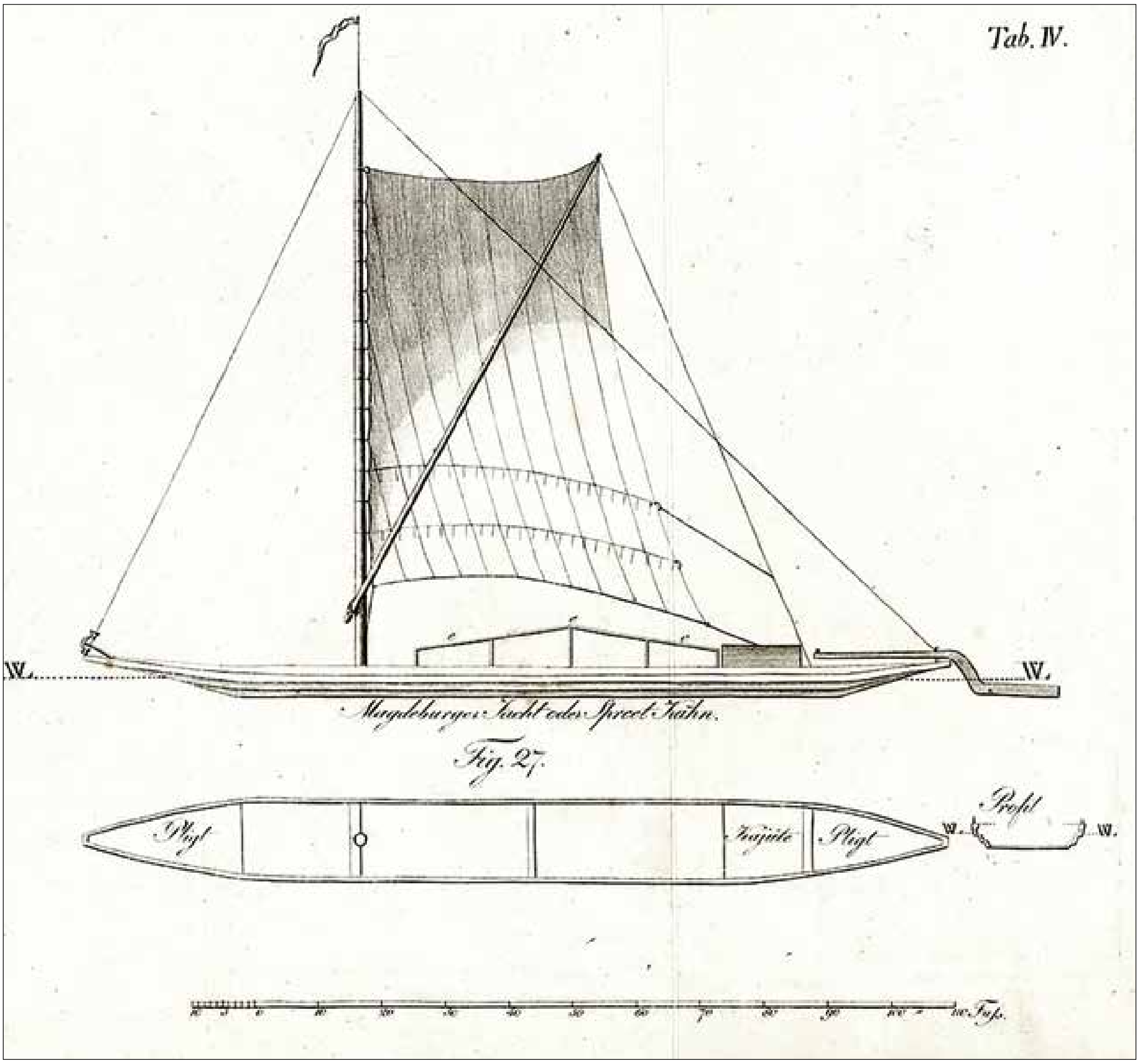

Fig. 3. *Spreetkahn* or *Magdeburger Jacht,* circa 1800 (after: Woltman 1802, tab. IV).

To ensure unimpeded access to the Baltic Sea, the old route through the Świna Strait was deepened and its entrance secured by establishing a port in Świnoujście (German: *Swinemünde*). Furthermore, a series of investments were made along the Oder River to improve its navigability. The riverbed was straightened, with old dams and structures either modified or completely removed. The construction of new canals and the reconstruction of older ones enabled the Oder to connect to the broader network of European waterways. Another significant development during this time was the abolition of outdated customs fees and staple rights, some of which had been in place since the 13th century.[9]

Nevertheless, all these efforts to develop inland navigation would have been unsuccessful without the appropriate vessels. Over the course of the 18th century, the narrow and elongated *Kahn* gained widespread popularity, eventually superseding other vessel types on the rivers of Central Europe.[10] Its success lay in its innovative construction: the flat-bottomed, slender hull made it ideally suited for navigating narrow locks and canals. The overall size of the hull varied by region and was adapted to the

[9] Sohn 2013, 10; Uhlemann 1996.

[10] Litwin 2019, 211; Mielcarek 1970, 379.

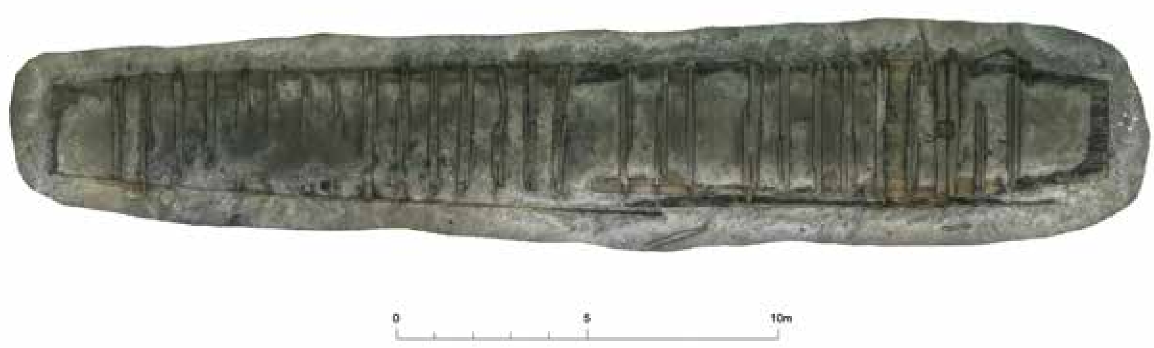

Fig. 4. Photogrammetric plan of the Peenemündung, Ostsee Bereich VII, Fpl.125 shipwreck site (compiled by P. Stencel in 2019; copyright: Landesamt für Kultur- und Denkmalpflege Mecklenburg-Vorpommern).

specific conditions of particular waterways, from which their names were derived, such as the Oder-*kahn*, Havel-*kahn* or Elbe-*kahn* (Fig. 3).

The late 18th century *Kahn*-type vessel from the Oder River (*Oderkahn*) measured approximately 30–45 m in length and 4–5 m in width, with the height at midship reaching 1.3–1.5 m.[11] Oak timber was the preferred material for the wooden hull construction, although it was common practice to mix various wood species. Frequently, the sides were constructed from oak, while the bottom was made of pine or spruce. This combination significantly reduced the hull's weight and, consequently, its draft.[12] The vessel was keel-less, featuring a flat-bottomed floor made of edge-to-edge joined planks. The sides were built using the mixed clinker and carvel fashion, with the two lowest strakes fastened in the clinker manner and the remaining upper ones, typically two or three, in the carvel technique.

A distinctive feature of the early *Kahn*-type vessel was its specially designed bow and stern. Until the second half of the 19th century, most of these ships featured a structure known as the *Kaffe*, created by bending the bottom planks firmly upwards. These elevated sections provided enhanced protection for the vessel's ends, particularly when navigating shallow waters or stranding along the shoreline. In some designs, the upward-curved *Kaffe* was constructed as a separate element, attached to the rest of the bottom by a transverse crossbeam. However, this solution introduced a structural weakness in the hull, leaving it particularly vulnerable to impacts from obstacles on the riverbed.[13] A more sophisticated solution involved interconnecting the planks in a herringbone pattern, which provided greater durability and resilience. By the 18th century, both the bow and aft end shared similar shapes and proportions, collectively accounting for as much as 33% of the total hull length.[14] Most *Kahn*-type ships during the 18th century were equipped with a single mast and a spritsail positioned about one-third of the hull's length from the bow. The crew typically consisted of three to four men. At the stern of the vessel, there was a small cabin (so-called *Bude*) for the skipper and his family. Additional accommodations for the remaining crew members might have been located at the bow, beneath the forward half-deck. The rest of the hull was allocated for cargo, giving these vessels an average capacity of 30–50 t.[15] The lifespan of a vessel was largely determined by the quality of timber used in its construction. Hulls made entirely of oak had an average lifespan of 10 to 12 years, while those constructed from pine lasted only 5 to 6 years.[16]

The Shipwreck of Peenemündung, Ostsee Bereich VII, Fpl. 125: An Example of the Late 18th – Early 19th Century Kaffenkahn

The site is located approximately 3 km northwest of the Lubmin Harbour at a depth of 8 m, on a relatively compact seabed of marine sand. Only a small portion of the original hull structure has been preserved, consisting of bottom planking and 27 partially intact frames. The total length of the wreck was measured at 27.5 m, with a maximum width of 3.6 m (Fig. 4).

Although the wreck was discovered relatively close to the shoreline, the missing upper parts of the hull and

[11] Hoyer 1793, 148.
[12] Kostecki 1826, 123.
[13] Sohn 2013, 41.
[14] Mielcarek 1986, 24.
[15] Mielcarek 1970, 387.
[16] Kostecki 1826, 121–123.

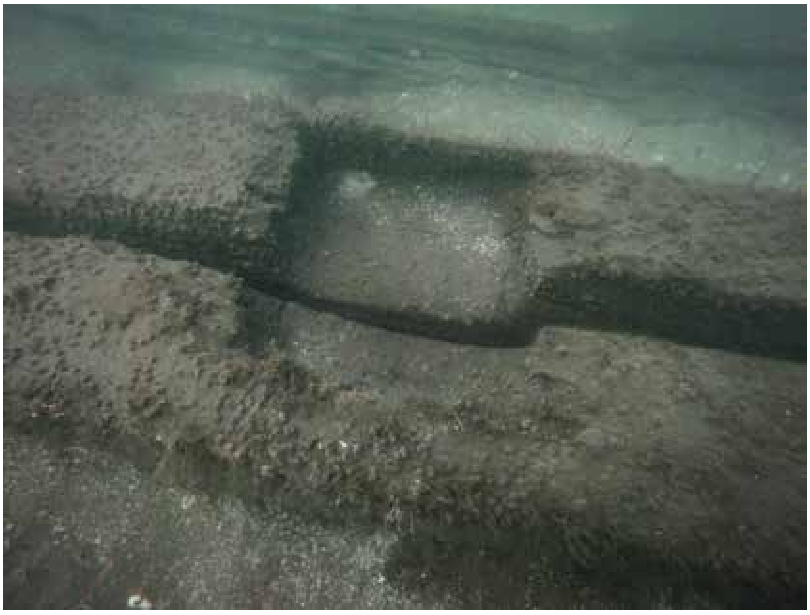

Fig. 5. Shallow mast step cut on top of two adjoining frames (photo by J. Ulrich 2019; copyright: Landesamt für Kultur- und Denkmalpflege Mecklenburg-Vorpommern).

the absence of cargo make it impossible to determine the cause of the vessel's loss or its intended destination. A few loose fragments of side planking found near the wreck suggest that the rest of the structure either deteriorated and was carried away by currents or that the whole preserved section was moved by waves from a more distant, unknown location.

The nearly complete bottom of the hull consists of ten strakes of edge-to-edge joined oak planks, each measuring between 28 and 32 cm in width and approximately 4 cm in thickness. Characteristic transverse straight cuts at both ends of the wreck indicate that the bow and stern were originally equipped with separate sections, shaped into elongated, triangular forms of *Kaffen*.

Each frame station consisted of two adjacent L-shaped frames. The shorter arms of these frames extended upward on either the port or starboard side, while the longer, horizontal arms tapered toward the opposite ends. This configuration created a scarf-like joint between adjacent elements, allowing the frames to span the entire width of the hull. In contrast, the shorter, vertical arms of the frames were preserved only in small fragments, covering just two to three strakes of side planking. At the bottom, each shorter arm was fitted with a rectangular joggle, designed to accommodate the overlapping connection between the two lowermost strakes. A single square mast step, located at the third frame station from the forward end of the vessel, measures approximately 40 × 40 cm with a shallow depth of 19 cm. It is carved into the top of two adjacent frames (Fig. 5).

A brief examination of the shipwreck site revealed only a small number of minor artefacts potentially related to the vessel's equipment and cargo. These included a small-sized anchor with four flukes and a single brick found near the mast step. Although it is difficult to identify the specific cargo based on these individual items, the presence of the brick might suggest the transportation of building materials.

Despite the shipwreck's state of preservation, certain visible structural features allow for an attempt at preliminary reconstruction of the ship's original appearance and dimensions (Fig. 6). Based on available records of Oder vessel classifications from the 18th century, the overall dimensions of the vessel can be estimated at approximately 40–42 m in length and 4.5–5 m in maximum width.[17] This suggests the use of relatively elongated bow and stern sections, with estimated lengths of 7.5 m and 6.5 m, respectively. Such dimensions align with the placement of a single mast, typically positioned at one-third of the hull's length. With a total of five strakes along the sides, the hull's depth can be estimated at approximately 1.5 m. These dimensions indicate a relatively large inland vessel, possibly of the Oder-*Kaffenkahn* size and type, with an estimated cargo capacity of about 70 t.

The *Kaffenkahn* ship was designed as an efficient and low-cost bulk carrier. Until the end of the 18th century,

[17] Mielcarek 1986, 25; Sohn 2013, 14–15.

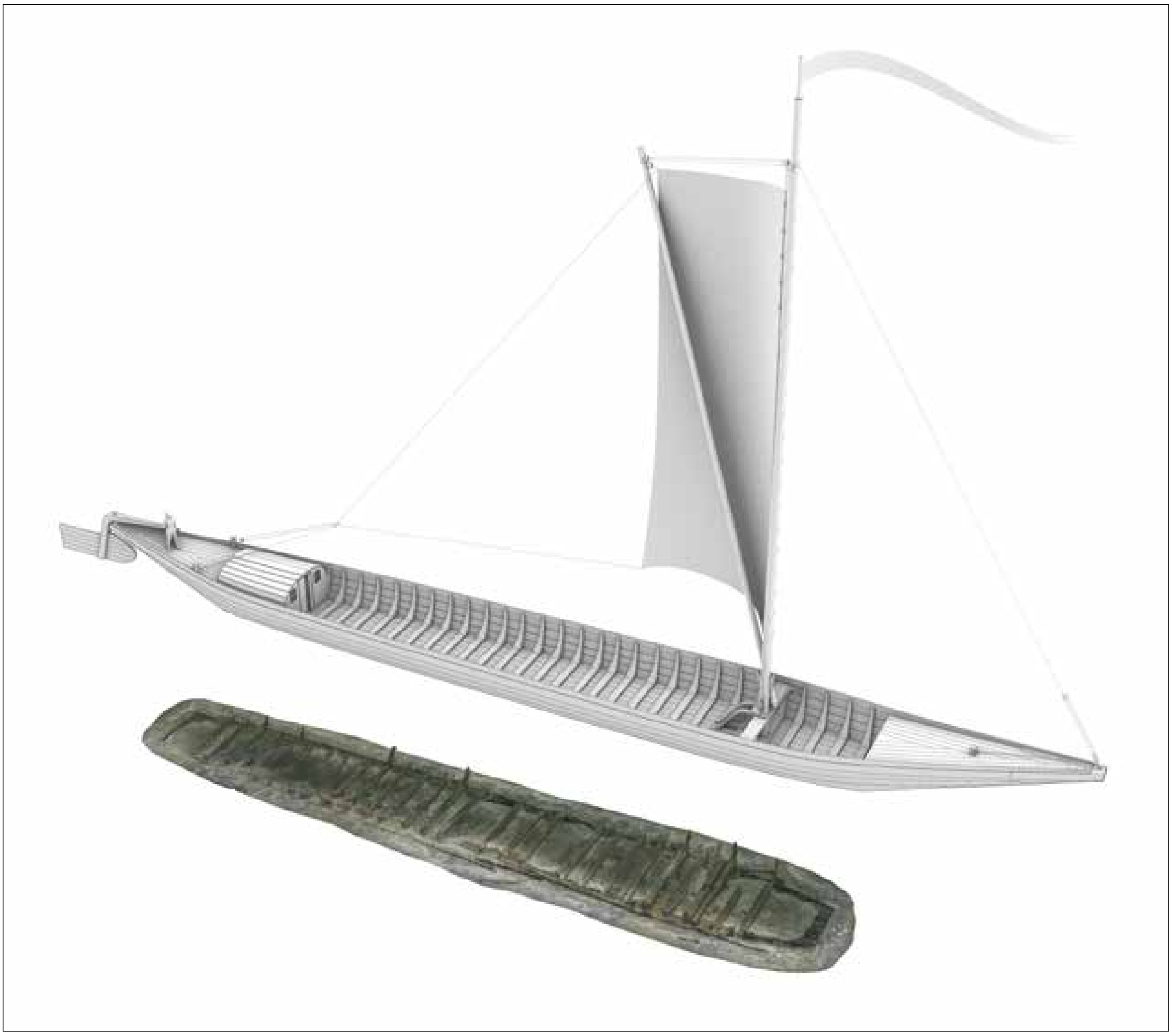

Fig. 6. Attempt at the digital reconstruction of the Peenemündung, Ostsee Bereich VII, Fpl.125 (compiled by M. Grabowski).

grain was the most commonly shipped cargo on the Oder River, exported from the hinterland, primarily the Greater Poland district, and later delivered to Western and Scandinavian countries.[18] Alongside grain, oak was another key export product. As a fundamental material for shipbuilding, oak timber was in high demand, particularly in Scandinavian countries, which lacked sufficient high-quality timber and relied on imports from the southern Baltic coast.[19] Although no archaeological evidence has been discovered to confirm long-distance timber trade on the *Kahn*-type ships, the presence of shipwrecks like Fpl. 125 proves that these vessels, with their large cargo capacity, could be used for transporting bulk goods within the sheltered coastal waters of the south-western Baltic.

On the Threshold of Industrialization – Challenges and Opportunities for the Pomeranian Inland Shipping

The unification of Germany in the second half of the 19th century laid a solid foundation for economic expansion, resulting in nearly uninterrupted growth until the World War I. The development of a unified system of weights and measures, a single currency, and standardized

[18] Chojnacka 2007; Szultka 2015, 190.

[19] Ressel 2012, 84.

administrative procedures greatly stimulated trade and strengthened the domestic market. This economic momentum was further enhanced by the technological innovations of the Industrial Revolution. The introduction of steel and iron, along with significant advancements in transportation – such as the emergence of railways – and the mechanization of various sectors of the economy, propelled Germany's transformation from a predominantly agrarian society into a modern industrial nation with a robust agricultural sector.[20]

The harbour cities of Bremen and Hamburg benefited the most from the new economic circumstances. Both had convenient connections to Germany's industrial heartland in the south (via the Weser and Elbe rivers), which allowed them to play a significant role in maritime trade. During the Industrial Revolution, the burden of this trade shifted increasingly toward the North Sea. For the Pomerania region, particularly Szczecin, this shift meant even fiercer competition in the shipping market compared to previous decades. A severe blow was dealt with the introduction of the railway. Between 1871 and 1914, Germany's railway network nearly tripled in length, establishing vital connections between the country's pivotal economic centres.[21]

Nevertheless, the Pomerania's natural resources supported the development of a locally based economy, supplying nearby regions with the necessary raw materials and semi-finished goods. One of the key local products, mass-exported not only to neighbouring areas but also to other German and Danish ports on the Baltic Sea, were bricks. Torgelow, located near the mouth of the Uecker River into the Szczecin Lagoon, was a well-known brick production hub. By the turn of the 19th and 20th centuries, approximately 50 brick factories operated in the area, producing 180 million bricks a year. Simultaneously, the region became a significant centre for cement production and distribution. The first cement factory in Szczecin was established as early as 1850, marking the beginning of the industry's growth. The abundant deposits of limestone and chalk in Pomerania, especially on the Rügen Island, were essential to this development. The growth of the cement industry in Szczecin led to a surge in demand for chalk, which was imported from Rügen, with inland transport playing a crucial role in efficiently distributing cement throughout the coastal harbours.[22]

To meet the increasing demands for transportation, extensive regulations and modernizations were required for the waterways on the Oder River. The main route to the open sea through the Peene Strait became insufficient and unprofitable due to the growing tonnage of maritime shipping. As a result, the shorter and less winding route through the Świna River was considered more feasible. In 1880, after six years of work, the construction of the new shipping route – *Kaiserfahrt* was completed, and the entire waterway from Świnoujście to Szczecin was deepened to 7–8 m.[23]

At the same time, the inland canals connecting the Oder River with other waterways were either modernized or newly constructed. In 1891, the *Oder-Spree* Canal was completed, and in 1914, the *Oder-Havel* Canal was finished, replacing the old *Finow* Canal, which had been in use since the 17th century.[24] By the end of the 19th century, the Oder River was regulated and canalized all the way to the industrial region of Silesia. In 1853, the so-called *Finow-Mass* was established by law as the upper limit for the length and width of vessels for use in the *Friedrich-Wilhelms* Canal, Finow Canal, as well as on the Havel River, from Liebenwalde to the estuary of the Spree near Spandau.[25] However, as economic development continued to grow and demands for inland transportation increased, even this restriction became incompatible with the dynamic changes in the industry.

All these changes also impacted the fleet of inland ships. In the relatively short period of 1872–1912, the total number of registered vessels on the Oder River increased from 2,289 to 4,432, while the average tonnage of a single ship grew from 65 to nearly 240 BRT.[26] To maximize the ships' capacity, their sides began to be arranged more vertically. Also, the length of the *Kaffe* (both, aft and bow) began to decrease and were finally replaced by a straight timber of the stern- and stempost, making the vessels more suitable for towing by steam-powered tugs. As a result, the specialization of inland vessels became more pronounced and associated with particular canals or even locks. For example, an *Oderkahn* capable of passing through the Finow Canal was referred to as a *Finowmässige Oderkahn*, while vessels travelling between Szczecin and Frankfurt (Oder) were known as *Frankfurter Oderkähne*.

During that time, vessels known as *Haff-* or *Pommernkahn* became popular on the Lower Oder and its estuary. These were larger variants of the *Oderkahn*, better suited for navigation on the open waters of the Szczecin Lagoon (Fig. 7). The average length of

[20] Abrams 2006, 17–18; Feuchtwanger 2001, 67–69.
[21] Łuczak 1984, 38.
[22] Sohn 2022, 9–11, 16–20.
[23] Kotla 2008, 141–143.
[24] Keweloh 2005; Miłkowski 2003, 20, 22–23.
[25] Sohn 2013, 10.
[26] Mielcarek 1986, 28.

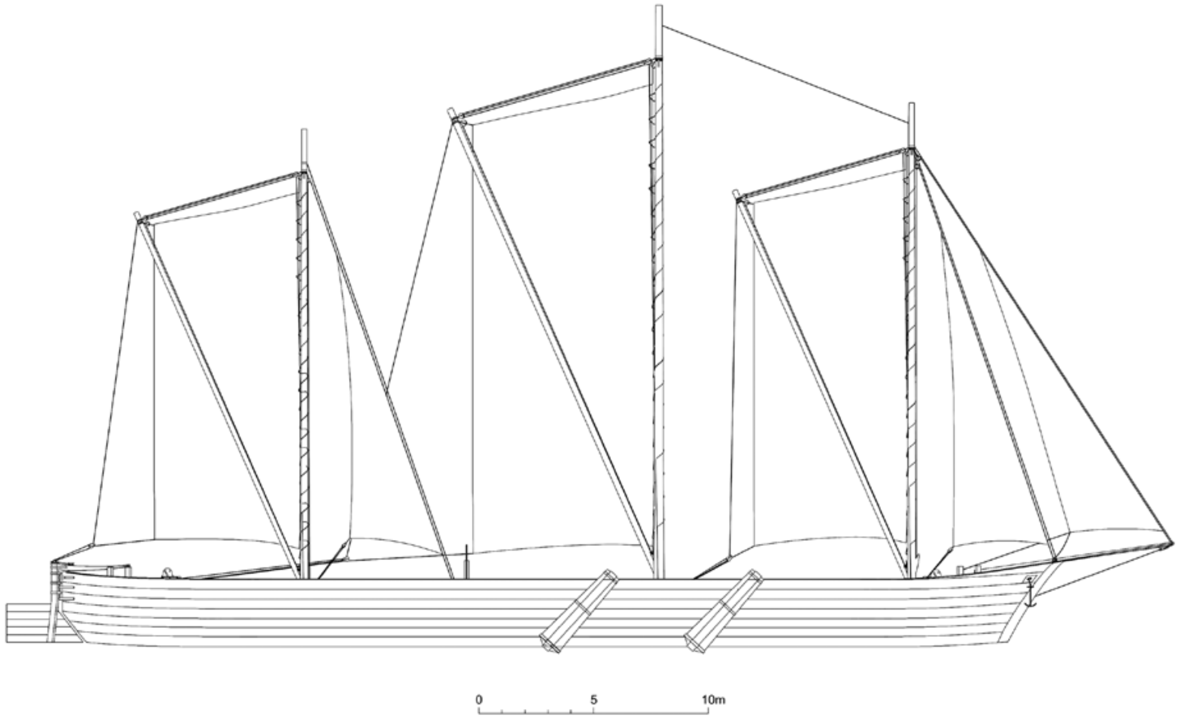

Fig. 7. Profile plan of a typical *Haffkahn*-Type vessel (compiled by M. Grabowski).

their hulls reached up to 44 m, with a width of 5 m. The growing demand for increased vessel capacity also influenced the design of the *Haffkahn*'s ends. By the end of the 19th century, these vessels were being equipped with sharp stemposts, resembling the curved bows of the popular schooners of that era. Also, the stern of the vessel underwent significant modifications. In older constructions, the rudder was mounted at the tip of the sternpost with a massive iron bolt. However, this led to frequent breakage of the fastening.[27] In later constructions, the aft of the vessel was shortened and the centrally located bolt was replaced with several gudgeons spread along the vertical sternpost, to accommodate a hinged rudder (Fig. 8). This change not only improved manoeuvrability but also expanded the cargo capacity of the hull without affecting its overall length.

Like the other *Kahn*-type vessels, *Haffkahn* was designed as a flat-bottomed vessel without a keel or keel plank. To improve seaworthiness during coastal voyages on the Szczecin Lagoon and the open sea, the sides of the hull were raised with additional outer planking strakes. The ships were also equipped with two to four wooden leeboards mounted on the midship.[28] Another improvement was made to the rigging. Starting in the 1840s, larger types of *Haffkahn* were outfitted with two, and soon after, with three sprit-rigged masts.[29]

Shipwreck Peenemündung, Ostsee Bereich VII, Fpl. 81 Shipwreck Site – Early 20th Century Coal Barge of the Haffkahn Type

The shipwreck is located approximately 5 km northeast of the entrance to Lubmin Harbour, at an average depth of 8.6 m. The elements of the wreck were widely scattered, with some found more than 100 m away from the main site. Despite several archaeological campaigns conducted between 2016 and 2019, the investigation of the main wreck site was limited to only a few dives. Therefore, only a short examination of the hull construction was possible at that time.

From the original construction of the vessel, the bottom of the hull survived almost intact, measuring ap-

[27] Teubert 1912, 401–403.

[28] Sohn 2013, 27.

[29] Sohn 2022, 106.

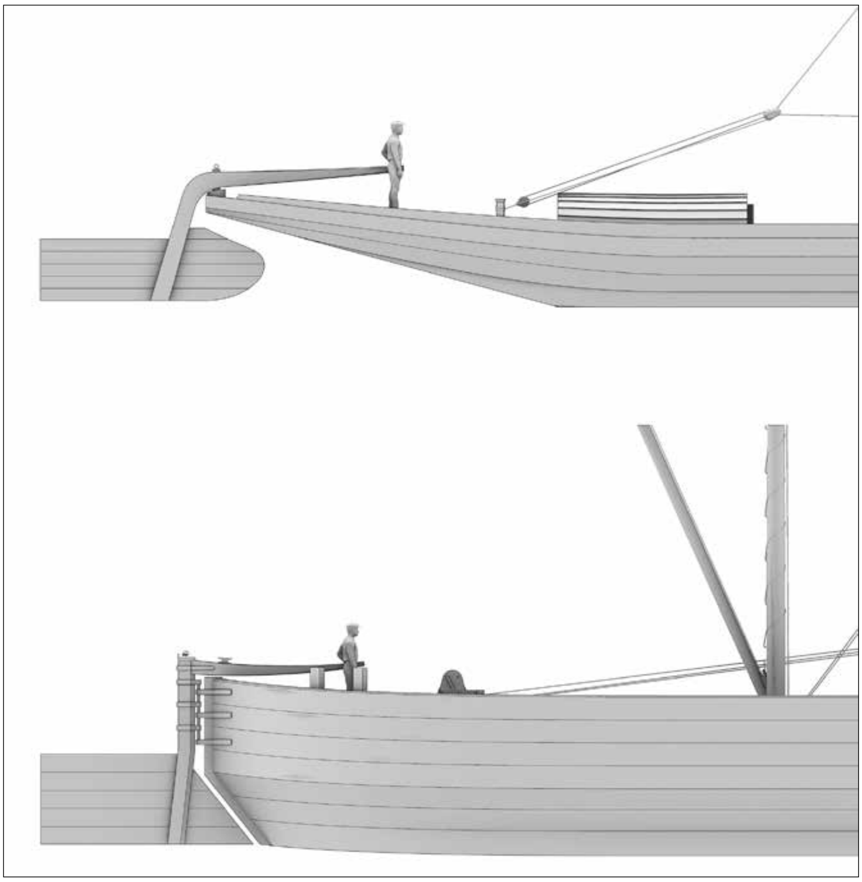

Fig. 8. Comparison between the late 18th century *Kaffenkahn* rudder mounting (above) and early 20th century hinged rudder on the *Haffkahn* (below); (compiled by M. Grabowski).

proximately 38 m in length and 5 m in width (Fig. 9). Apart from the protruding ends of the frame stations, most elements of the upper hull structure were washed away and scattered across the site. These scattered components include parts of the side planking, fragments of frames, and remnants of the main cargo – coal briquettes that covered the whole ship's bottom. It is very likely that the floor was flat and consisted of edge-to-edge joined planks, with no keel or keel plank present.

The framing system consists of wooden frame stations spaced approximately 80 cm apart. Each station includes a flat oak floor timber that spans the entire bottom of the vessel and is secured with trenails. Aft of each long floor timber, shorter L-shaped timbers are attached to the floor planks and extend upward to form the sides of the barge. These futtocks were not directly connected to the floor timbers. Continuations of the futtocks were observed abutting the ends of the initial futtocks and running along the floor across the bottom of the vessel (Fig. 10).

All the investigated outer planks were sawn from oak and measured approximately 8 cm in thickness. Their width was estimated to range between 30 and 42 cm. While none of the investigated planks of the side construction appeared to be preserved in their full length, planks measuring 10 m or more were observed on site and in the vicinity of the hull. A distinctive feature of this shipwreck is the method used to connect neighbouring planking strakes. These were joined using oblique iron nails driven diagonally from the inside of the upper planks into the lower planks. On the outboard side, a rabbet or notch measuring 3 cm wide and 1.5 cm deep was cut along the edges where the planks adjoined. This was covered with a wooden lath 1.5 cm thick and 6 cm wide. The purpose of the lath was to secure a waterproofing material applied between the strakes.

Despite the vessel's poor state of preservation, an examination of both ends provided some insights into the construction of the stern and bow sections. The close proximity of the outer planks on both sides suggests that, instead of a *Kaffe*, the vessel was equipped with posts at both ends. Near the northern end, fragments of chamotte tiles were discovered. These may have been part of the inner lining of an oven, a basic feature typically found in the aft cabin.[30] It is also possible that another

[30] Sohn 2013, 134.

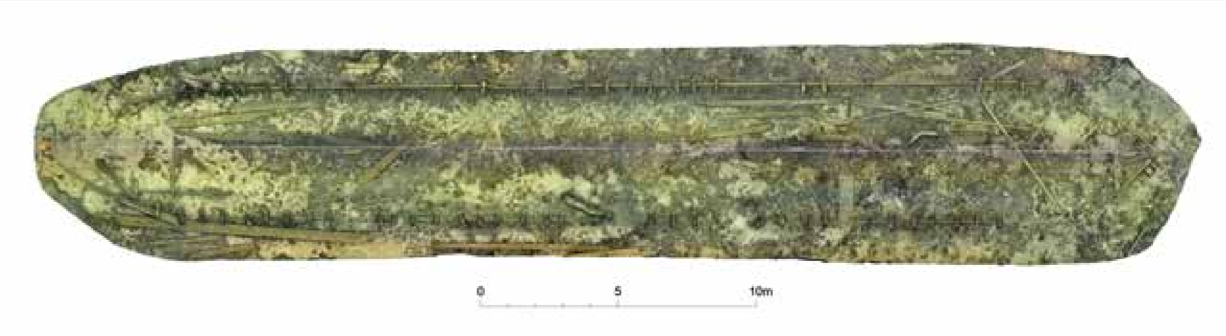

Fig. 9. Photogrammetric plan of the Peenemündung, Ostsee Bereich VII, Fpl.81 shipwreck site (compiled by P. Stencel in 2017; copyright: Landesamt für Kultur- und Denkmalpflege Mecklenburg-Vorpommern).

Fig. 10. Bottom of the shipwreck hull and the exposed components of frame stations – futtocks and floor timbers (photo by M. Grabowski; copyright: Landesamt für Kultur- und Denkmalpflege Mecklenburg-Vorpommern).

smaller cabin was located at the bow, under the half deck, as indicated by other small artefacts uncovered in the forward section.

One of the largest elements of the shipwreck is the rudder. Its construction features a 3.4 m long asymmetric oak stock and a curved tiller. Originally, the stock was attached to the gudgeons on the sternpost using three iron pintles, which were secured with metal bands. Several pine planks found near the rudder may have been part of the blade. The diagonal endings observed on two of these planks are characteristic of the inner structure of a rudder blade. The rudder exemplifies the so-called balance rudder (*Wippruder*), a design typical of Pomeranian *Kahn*-type vessels.[31] In this type of rudder,

[31] Sohn 2013, 50.

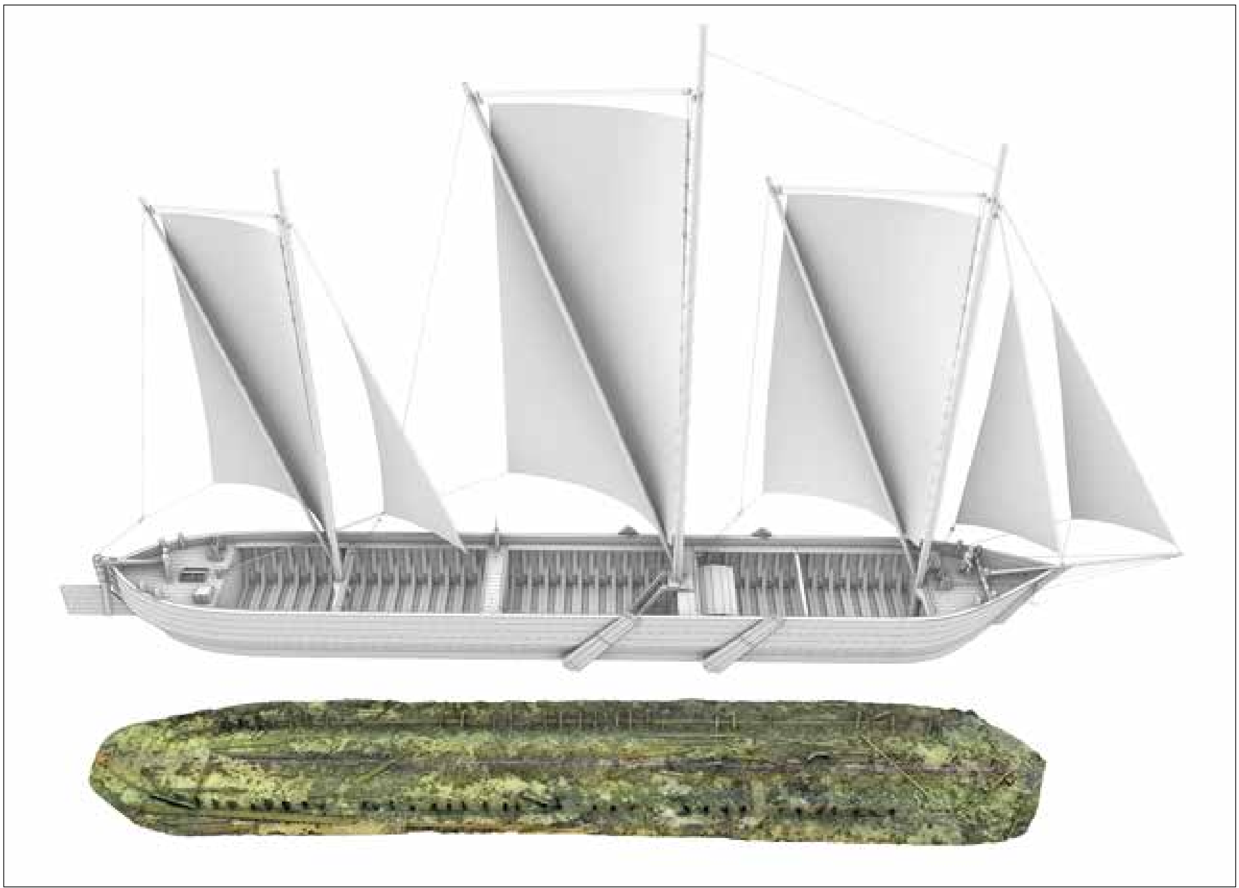

Fig. 11. Attempt at the digital reconstruction of the Peenemündung, Ostsee Bereich VII, Fpl.81 (compiled by M. Grabowski).

the blade extends beneath the sternpost to enhance hydrodynamic efficiency without increasing the vessel's overall length – an important feature for navigating narrow canals and locks. Additionally, the blade extension improved handling by balancing the water pressure on both sides of the blade as the vessel moved, reducing the effort required to steer.

The Peenemündung Fpl. 81 shipwreck can be conclusively classified as representative of the *Haffkahn* or *Pommernkahn* type. Based on the preserved hull remains, its length is estimated to approximately 40–41 m, with a beam of 5–5.6 m. Considering the size of the rudder, the vessel's height could have between 2.5–3 m. Evidence from the rudder and rigging suggests that the vessel was self-propelled, likely using one or more sails (Fig. 11). A significant feature of the site that aids in identifying the wreck is the cargo of coal briquettes. These briquettes were found both within the wreck and scattered throughout the surrounding debris field. All of them are uniform in size and shape, representing the so-called *Salon-briquettes* or *Hausbrand*, used for domestic purposes.[32] The briquettes are marked with the names of their manufacturers or brands: *KAISER* and *Ilse Bergbau ActGes*, alongside a decorative motif of the moon and stars (Fig. 12). Those briquettes were produced by *Ilse Bergbau Actiengesellschaft*, a company founded in 1888 as the successor to *Kunheim & Co.*, a Berlin-based chemical production firm that had established a coal mine in the Lausitz region to reduce fuel costs. The company expanded rapidly as demand for coal briquettes surged in the early 20th century. The size and decorative features of the *Ilse Bergbau ActGes* briquettes suggest their production at the *Marga I* or *Marga II* facilities in Brieske near Senftenberg. Most briquettes produced by *Ilse Bergbau Actiengesellschaft* were sold in Berlin and transported there by train. Szczecin, the nearest export harbour to Berlin, was accessible via both train and inland waterways. Briquettes were also transported directly by train from Senftenberg to Szczecin.[33]

[32] Keilhack 1913, 90.

[33] Keilhack 1913, 112

Fig. 12. Two types of coal briquette recovered from the site (photo by M. Grabowski; copyright: Landesamt für Kultur- und Denkmalpflege Mecklenburg-Vorpommern).

The vessel could, therefore, have been loaded in Berlin or Szczecin and may have been bound for Greifswald or Stralsund when it was lost in the Bay of Greifswald. Some insight into the fate of the wreck may be provided by a brief anonymous note found in the archives of the State Heritage Authority of Mecklenburg-Vorpommern (German: Landesamt für Kultur- und Denkmalpflege Mecklenburg-Vorpommern). This note describes events from 1924 when a *Haffkahn* carrying a cargo of coal briquettes sank in the Bay of Greifswald at a depth of 8.5 m. The coordinates and depth of the sunken vessel match the location of the Fpl. 81 shipwreck. However, beyond its location, cargo description, and mention of rigging still visible at the surface, the note provides no further details about the wreck or the events leading to its loss.

The Introduction of New Materials in the Construction of Pomeranian Inland Vessels

It is widely acknowledged that the first iron-built ship was the barge *Trial*, constructed by John Wilkinson in 1787, measuring 21 m in length. The construction of its hull incorporated wooden beams, posts, and a gunwale covered with iron plates fastened together using iron rivets.[34] By the first half of the 19th century, iron ships gained significant popularity on British waterways, marking a steady rise in their adoption. This trend expanded into large-scale seafaring in 1853 with the launch of the fully iron-hulled steamship *SS Great Britain*.[35]

The introduction of iron into Pomeranian shipbuilding, however, was a more gradual and long-term process. The first recorded mention of iron barges in this region dates to 1877. By the final decade of the 19th century, iron was increasingly used in constructing frames, sides, half-decks, and cabins, while the bottoms of vessels were still made entirely of wood.[36] In 1912, only 40% of registered *Oderkahn* vessels were constructed from iron. This slower adoption was primarily due to the technological limitations of local shipyards, which were small and ill-equipped to meet the demands of the industrial revolution. Although Germany was the world's largest producer of steel and iron before the World War I, wooden rivercrafts remained more cost-effective to produce than their iron counterparts.[37]

Despite these economic constraints, the advantages of the new materials were clear. Steel and iron were lighter, more durable, and could be shaped more flexibly than timber. These qualities were particularly advantageous for inland vessels navigating shallow riverine waterways. However, thin iron plates were less rigid and required additional longitudinal reinforcements. Moreover, iron-bottomed hulls were more susceptible to mechanical damage from underwater obstacles. These limitations likely led to the development of mixed wood-and-iron structures, which became typical for inland vessels from the late 19th century through the first half of the 20th century.

An example of such hybrid construction is a 21 m long wreck recovered in 2011 from the Oder River in the harbour of Szczecin.[38] Its bottom, including the planks and floor timbers, was made entirely of oak, whereas the vessel's sides were composed of riveted iron plates supported by iron futtocks (Fig. 13). A marking plate on the cabin's wall provided information about the

[34] McCarthy 2005, 143.
[35] Farr 1965.
[36] Teubert 1912, 274.
[37] Łuczak 1984, 25; Mielcarek 1986, 28–29.
[38] Grabowski, Ostasz 2016, 118–120.

Fig. 13. Detail shot on the hull's bottom of a barge shipwreck recovered from the Oder River in Szczecin in 2014 (photo by M. Grabowski).

vessel's origin, revealing that it was built in 1902 by *Johs. Thormählen & Co.*, a small family-operated shipyard in Elmshorn, Schleswig-Holstein. Bullet holes visible in the wooden bottom suggest that the vessel may have been sunk during an air attack in the World War II.

A mixed construction of Peenemündung, Ostsee Bereich VII, Fpl. 111

Another example of the early 20th-century mixed iron-and-wood Pomeranian rivercraft is the shipwreck Peenemündung, Ostsee Bereich VII, Fpl. 111. The site is located in the Bay of Greifswald, approximately 6 km north of Lubmin Harbour at an average depth of 6 m. This shipwreck site was also surveyed as part of several archaeological campaigns conducted between 2016 and 2019.

The wreck consists of a relatively small fragment of the hull, measuring 16 m in length and 2.2 m in maximum width (Fig. 14). The remains are almost entirely exposed on the seabed; however, the state of preservation prevents a definitive identification. It is unclear whether the structure visible on the seabed represents the bottom or the side of the vessel. The hull consists of five edge-to-edge joined strakes of oak planks, each with an average width of 27–37 cm and a thickness of 7 cm. The planks within each strake are connected by Z-shaped scarfs. As both ends of the hull are damaged and missing, the original length of the vessel cannot be determined. Nineteen frame stations are attached inboard of the planking, spaced approximately 50 cm apart. The frames are L-shaped, with the longer arm connected to the planking. The shorter arms, visible only from the northern side of the wreck, are bent upwards, indicating the turn of the bilge. All frames are secured to the planking with round metal bolts.

The wreck's width appears too narrow for the typical beam of an *Oderkahn* from this period. Additionally, the frames with upward arms on only one side suggest that this structure may belong to the side of the vessel rather than its bottom. Unfortunately, an examination of the immediate surroundings of the wreck did not reveal any additional components of its construction. This suggests

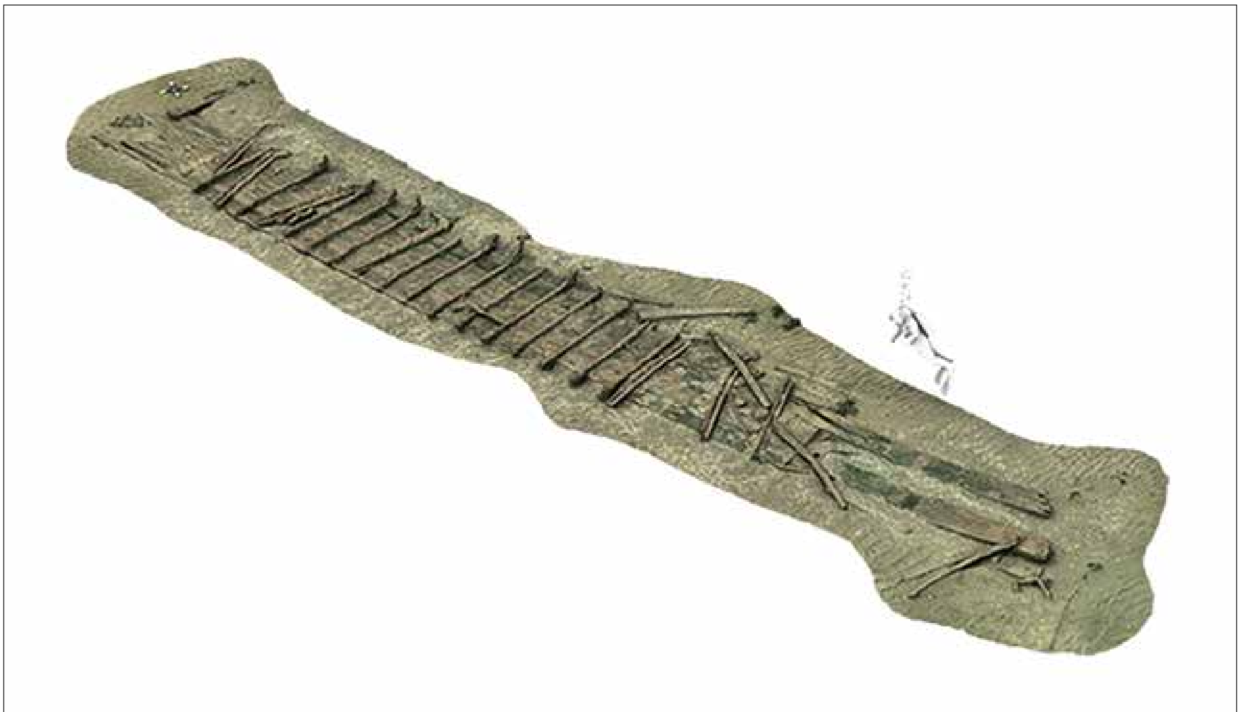

Fig. 14. Photogrammetry of Peenemündung, Ostsee Breich VII, Fpl.111 shipwreck site (compiled by P. Stencel in 2019; copyright: Landesamt für Kultur- und Denkmalpflege Mecklenburg-Vorpommern).

that the fragment may have been dislodged from its original, unidentified, location and carried away.

The Decline of the Sailing Ships on Pomeranian Waterways

Another innovation introduced during the Industrial Revolution that radically transformed navigation was steam engine. The advantages of this new propulsion method were evident, enabling the establishment of regular connections between inland harbours, which became largely independent of weather conditions, such as wind direction and seasonal strong river currents. However, the high costs associated with this technological change – including coal supplies, skilled specialists, and engine operators – meant it was initially accessible only to the wealthiest entrepreneurs. Thus, the first steamships appeared on the Oder River and in the Szczecin Lagoon during the 1830s.[39]

In response to these challenges, a common practice in the mid-19th century was the formation of shareholding companies. These companies were able to pool resources and provide fleets of steam-propelled ships and tugs to meet the growing demands of the market.[40] Gradually, masts and sails on river vessels were replaced with towing bitts, and eventually, diesel engines became the primary propulsion for self-propelled ships.

The World War II significantly accelerated changes in the Oder River fleet, affecting both the nature and scale of river transport. In 1945, the majority of the Oder vessels had been either sunk or destroyed. Most of the surviving ships were seized and relocated to the East by the Soviets. After the war, river transport technology underwent a fundamental shift. A more economical pushing system, utilizing entirely new types of barges and tugboats, began to replace traditional towing methods. This new method was significantly more efficient, as towing required greater power to pull barges against river currents, making it less energy-efficient. The pushing technique allowed for better control over the units and more efficient use of propulsion power.[41] By the 1950s, pushing had become the dominant method of river transport, surpassing traditional towing and driving further advancements in the field.

One of the last remaining examples of traditional Pomeranian-type vessels is the *Haffkahn Emma*, constructed between 1928 and 1929 in one of the lo-

[39] Miłkowski 2003, 20.
[40] Zawadka 1999, 136–137.
[41] Kulczyk, Winter 2003, 105; Reszka 2012, 54–56.

cal shipyards in Pölitz (now Police, near Szczecin). The hull of *Emma* was built entirely from riveted steel plates. Although it retained the traditional three-masted rigging characteristic of *Haffkahn* vessels, navigation through canals was assisted by a tug or motorboat. The vessel remained in use for several years after the war. In 1994, it was handed over to the Maritime Museum in Bremerhaven, where it is currently exhibited.[42]

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Northern Settlers by the Ślęza River at the Dawn of the Late Pre-Roman Iron Age

Abstract

Until recently, the earliest horizon of Lower Silesia's late pre-Roman Iron Age settlement was difficult to identify. Outside the Gubin Group area on the Middle Oder, few settlements and burials originating from this period were found. The paper presents a new interpretation of the archival records and pre-war settlement finds from Bielany Wrocławskie (*Bettlern*), Wrocław-Muchobór Mały (*Klein Mochbern*), and Wilczków (*Wiltschau*), as well as evidence from relatively recent rescue excavations in Wrocław-Muchobór Wielki. All of them are situated no further than a few hundred metres from the Ślęza River. Our interpretations shed new light on the initial stage of the late pre-Roman Iron Age around Wrocław and fill the settlement hiatus between the latest La Tène Culture settlement and the earliest Przeworsk Culture assemblages.

Keywords: Jastorf Culture, Przeworsk Culture, migration, settlement, archaeology, pre-Roman Iron Age, middle La Tène Period, Lower Silesia

Introduction

Our paper aims to present, analyse, and contextualise some unpublished evidence documenting the earliest stage of the late pre-Roman Iron Age settlement in Lower Silesia. As we have recently argued, many settlement sites traditionally dated to the late La Tène Period or the 1st century BC are substantially older.[1] Settlements situated in Bielany Wrocławskie (previously *Bettlern*), Wrocław-Muchobór Mały (*Breslau-Klein Mochbern*), and Wilczków (until 1937, *Wiltschau* and *Herdhausen* between 1937 and 1945) belong to this group (Fig. 1). Fortunately, much of the evidence from the excavations conducted in the 1920s and 1930s is still available in the City Museum of Wrocław – Archaeological Museum (Miejskie Muzeum Wrocławia – Muzeum Archeologiczne). Sadly, the same is not true of the archival records. Files containing data on the excavations in Bielany Wrocławskie went missing during World War II, and the information provided in the publications is scarce – if any.

More recently, another late pre-Roman Iron Age settlement site came to light during rescue excavations conducted in 2014 by the Akme company in Wrocław-Muchobór Wielki, Graniczna Street. Since a comprehensive study of these finds has recently been published,[2] we shall discuss only the most chronologically indicative feature here.

Bielany Wrocławskie (former *Bettlern*)

Excavations at an unspecified location in the village took place in 1926. The entire assemblage identified in the Wrocław museum consists of 14 pre-Roman Iron Age

[1] Dulęba, Markiewicz 2021, 383–384.

[2] Markiewicz 2024.

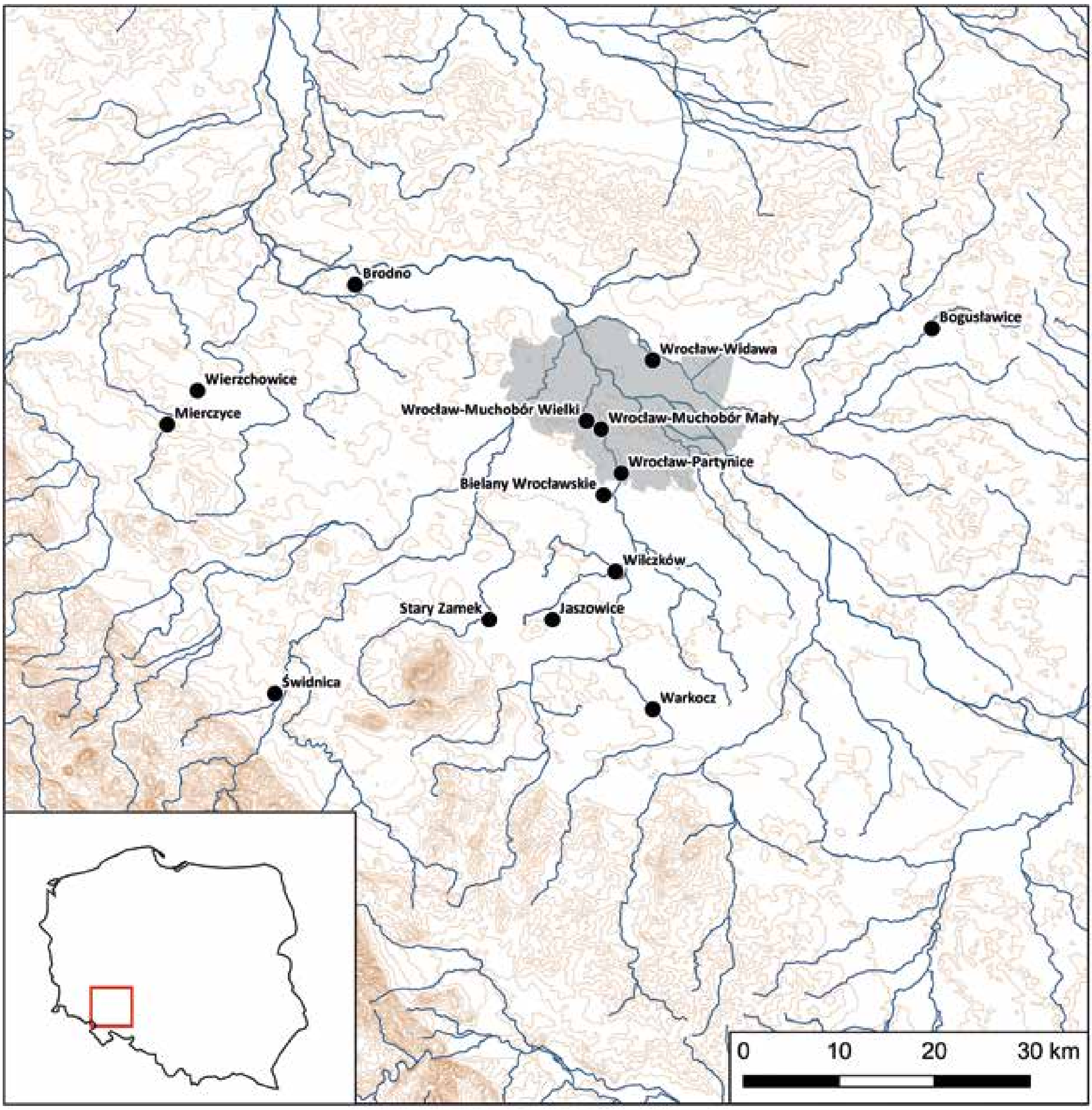

Fig. 1. Sites with Jastorf-style artefact finds from Lower Silesia (compiled by P. Dulęba).

potsherds, nine of which come from coarseware vessels, all fired in oxidation conditions. Judging by the inventory number (inv. no. 500:26), they were found in a single feature.

All of the five diagnostic sherds were rim fragments. Three were originally parts of unsmoothed cooking or storage vessels (Fig. 2: 2, 3, 5). Their rims were thickened and everted, and one featured two facets: on the inner and outer side (Fig. 2: 2). Tableware vessels had thin walls, smoothed surfaces, and everted rims. One of the rim fragments was thickened (Fig. 2: 1) and the other one not (Fig. 2: 4). The most diagnostically significant sherd is decorated with a clay strip featuring fingertip impressions (Fig. 2: 5). It has close matches at the nearby site in Wrocław-Partynice[3] and many other Iron Age sites in North Central Europe – from Jutland through Greater Poland and

[3] Dulęba, Markiewicz 2021, figs. 8: 4, 8; 16: 3.

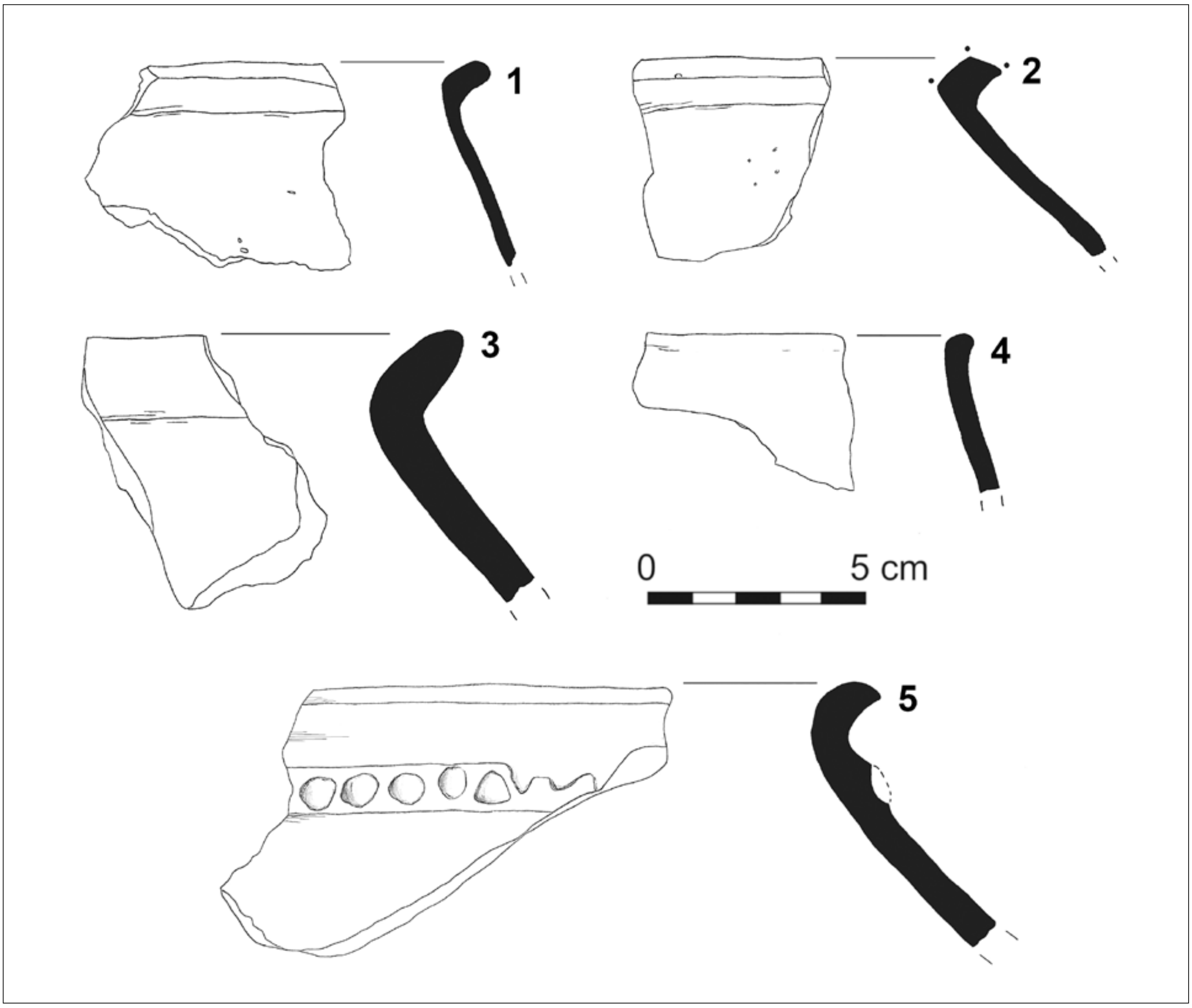

Fig. 2. Potsherds from Bielany Wrocławskie (*Bettlern*) (drawing by A. Dołbizno and J. E. Markiewicz).

Kuyavia to Upper Silesia.[4] However, such sherds barely occur in closed assemblages dated with chronologically sensitive artefacts. In the Polish Lowland, when they are recorded with pottery displaying features traditionally associated with the Przeworsk style, they might be dated to the initial stage of the late pre-Roman Iron Age.

Wrocław-Muchobór Mały (former *Breslau-Klein Mochbern*)

Isolated pre-Roman Iron Age finds occurred in Wrocław-Muchobór Mały, Site 1, at least as early as 1918–1919.[5] The site is located on a high terrace on the right bank of the Ślęza River (Fig. 3). In February 1927, a local teacher named Böthge sent to the museum some of the prehistoric potsherds which he had seen on the edge of a sandpit within a field. The excavations around the edge of the pit started the following spring. Most of the finds originated from the Neolithic, but features 5 and 6 (Fig. 4) came from the late pre-Roman Iron Age occupation stage.

The ground plan of Feature 5 was irregular, ca. 2 x 1.6 m. The feature was 0.35 m deep, and its top layer included traces of burning and a few stones, possibly re-

[4] Czerska 1959, fig. 9: 9; Grygiel 2018, 309–314; Hatt 1957, figs. 247, 261, 308, 309; Machajewski, Pietrzak 2008a, pls. 7: 1–2, 11: 2–4, 23: 5–6, 40: 3; Martens 1988, figs. 15: 6a, 16: 14; Martens 1997, fig. 3.

[5] APW, WSPŚ, sign. 653, file Breslau-Klein Mochbern, pp. 630–670; Vermehrung… 1922, 48.

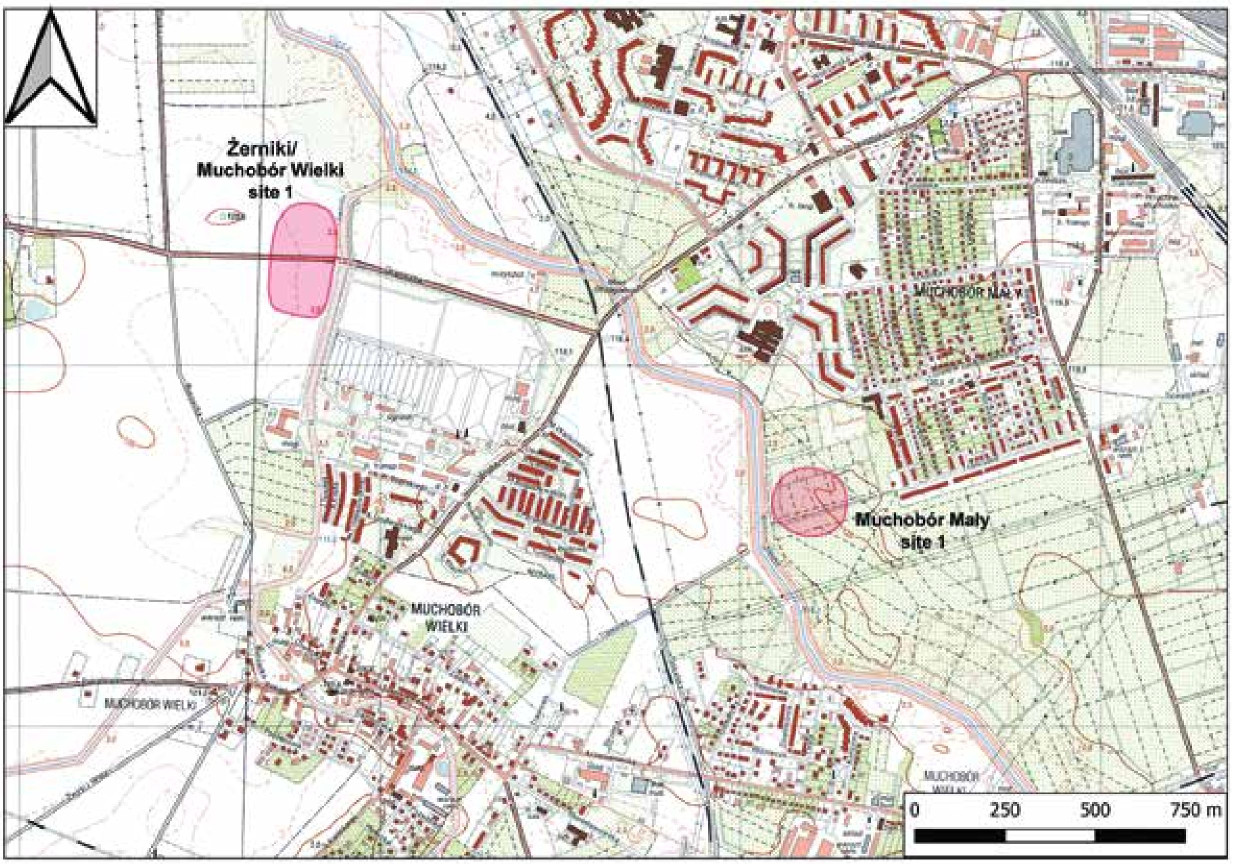

Fig. 3. Location of the discussed archaeological sites in Wrocław-Muchobór Mały (*Klein Mochbern*), Site 1, and Wrocław Muchobór-Wielki/Żerniki, Site 1 (compiled by P. Dulęba).

mains of a hearth (Fig. 5: 1). It yielded pieces of three clay loom weights (Fig. 6), iron slag, and potsherds, of which some were also heavily burnt.[6] Six of the twelve sherds identified in the Archaeological Museum in Wrocław (inv. no. 1131:27, 1133:27, 1134:27) were diagnostic (Fig. 7: 1–6). An additional four were sketched in the museum inventory book (Fig. 7: 7–10).

Feature 6 (circular, with a diameter of ca. 0.8 m) did not produce any finds except for an incomplete bronze fibula of the Mötschwil type (Fig. 5: 2).[7] Additionally, some late pre-Roman Iron Age potsherds were recorded in the cultural layer (inv. nos. 1141:27 and 1142:27 – Fig. 8). Both sherds from the feature and the cultural layer display stylistic traits linking them to the late Jastorf and early Przeworsk potting traditions. Two of the sherds from Feature 5 were parts of kitchen/storage vessels decorated with clay strips and fingertip impressions on the shoulder and roughened surfaces below it. As discussed in the previous section, they have many matches across the North European Plain. According to the sketch in the inventory book, the finds included a strongly everted, broad rim (Fig. 7: 8) featuring most likely three facets and a relatively small handle. Since the sketch lacks scale, it is difficult to determine what vessel it belonged to. However, its general morphology would situate it within the late pre-Roman Iron Age. Two sherds from the feature have meander-type linear decorations traditionally associated with the pre-Roman Iron Age Przeworsk style (Fig. 7: 1, 9). A similar sherd, with a decoration composed of triangles, was found in the cultural layer (Fig. 8: 7). Other sherds from the layer (except for one – Fig. 8: 2) were parts of coarseware vessels. The rims featured facets on their top parts and sometimes also on their inner side (Fig. 8: 1, 6).

Unfortunately, the preserved sherd assemblage is relatively small and does not include any fully reconstructed vessel forms. Thus, we might only securely state that they originated in the early stages of the late pre-Roman Iron

[6] Pescheck 1939, 221.

[7] Cf. Vermehrung… 1930, 98; Maciałowicz 2015, fig. 5: 3.

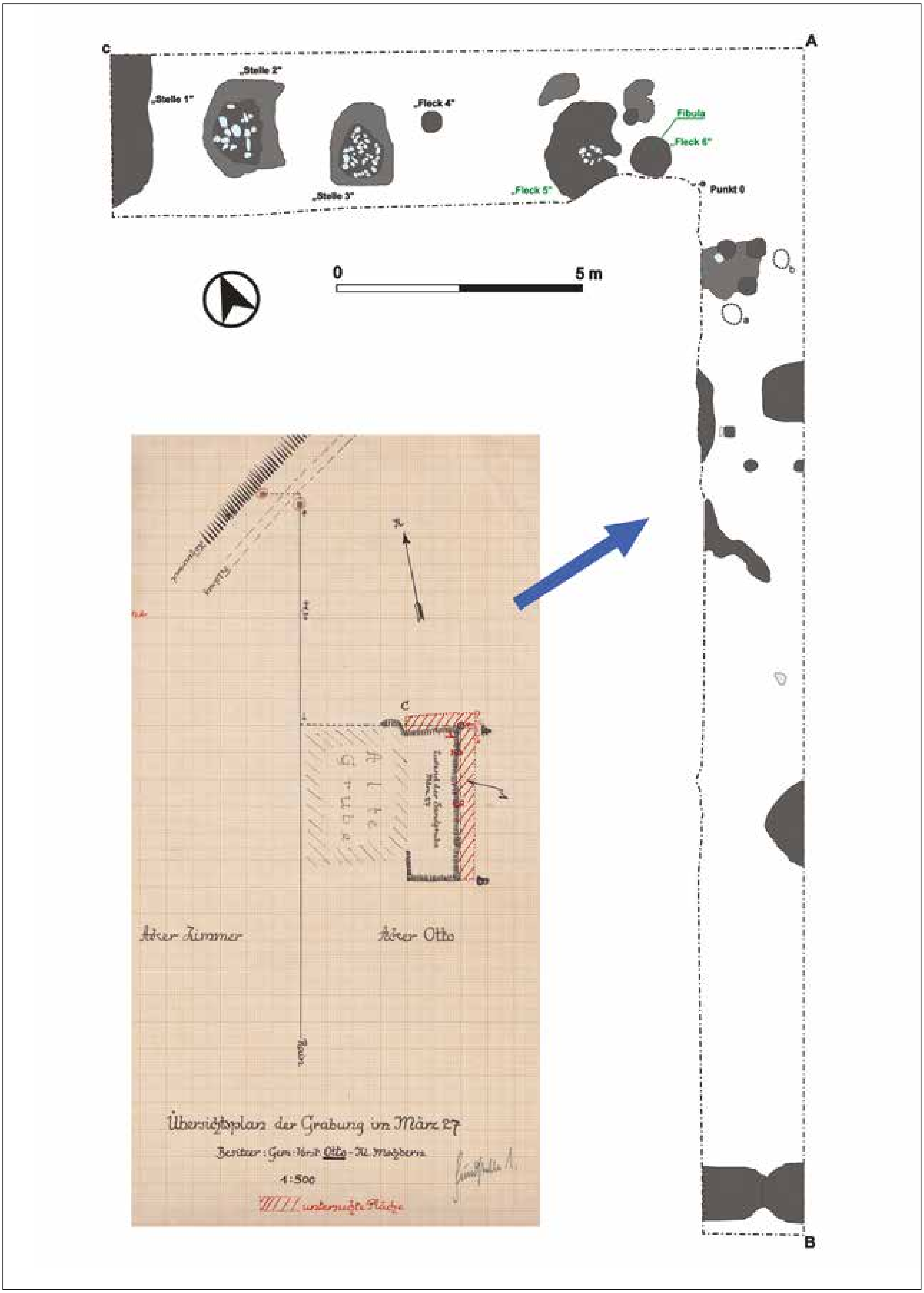

Fig. 4. Excavations in Wrocław-Muchobór Mały in 1927 (APW, WSPŚ, sign. 653, file *Klein Mochbern*, p. 650; compiled by P. Dulęba).

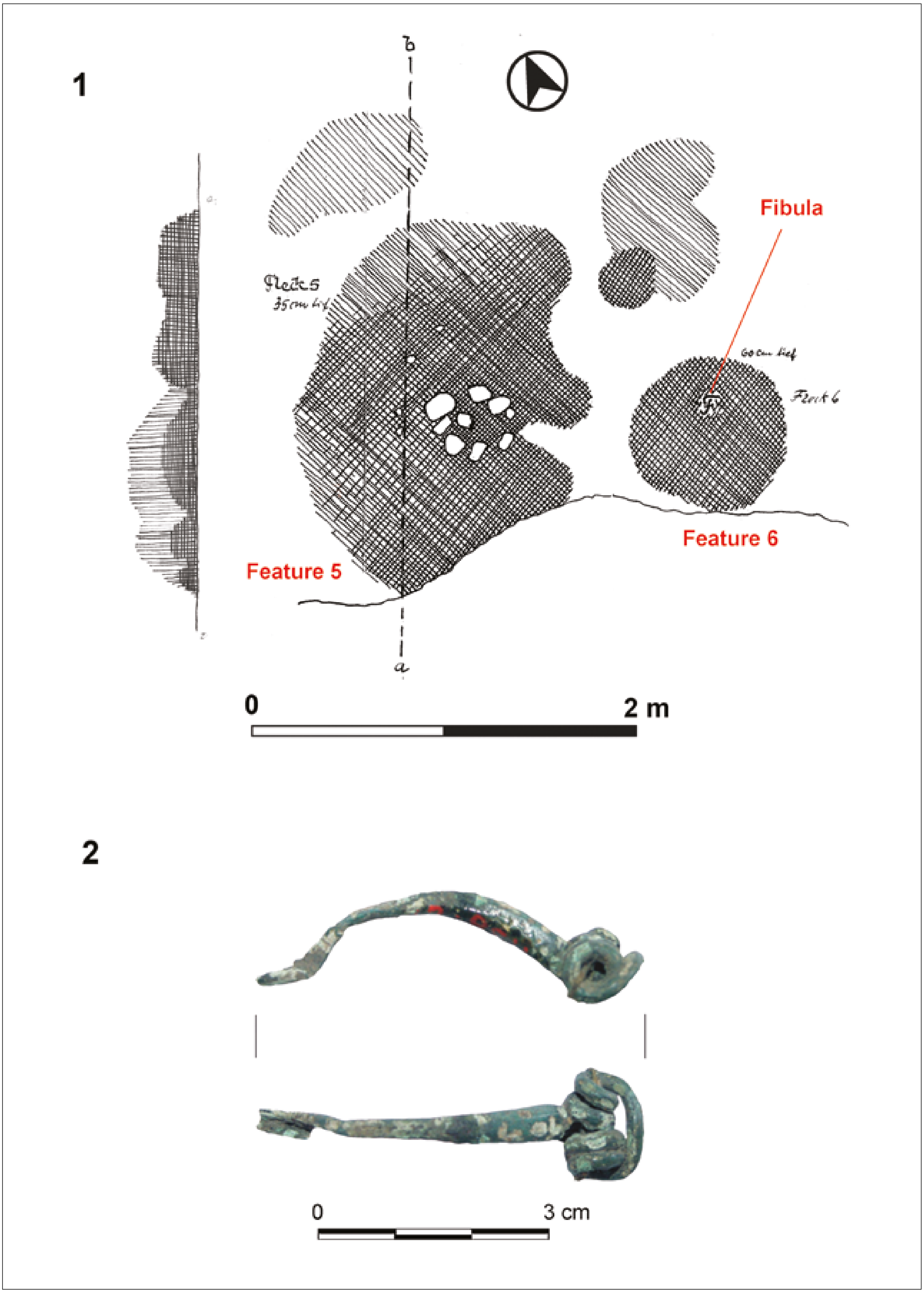

Fig. 5. Features 5 and 6 found in 1927 in Wrocław-Muchobór Mały (APW, WSPŚ, sign. 653, file *Klein Mochbern*, p. 647): 1 – ground plans of features 5 and 6; 2 – fibula found in Feature 6 (after: Maciałowicz 2015, fig. 5: 3).

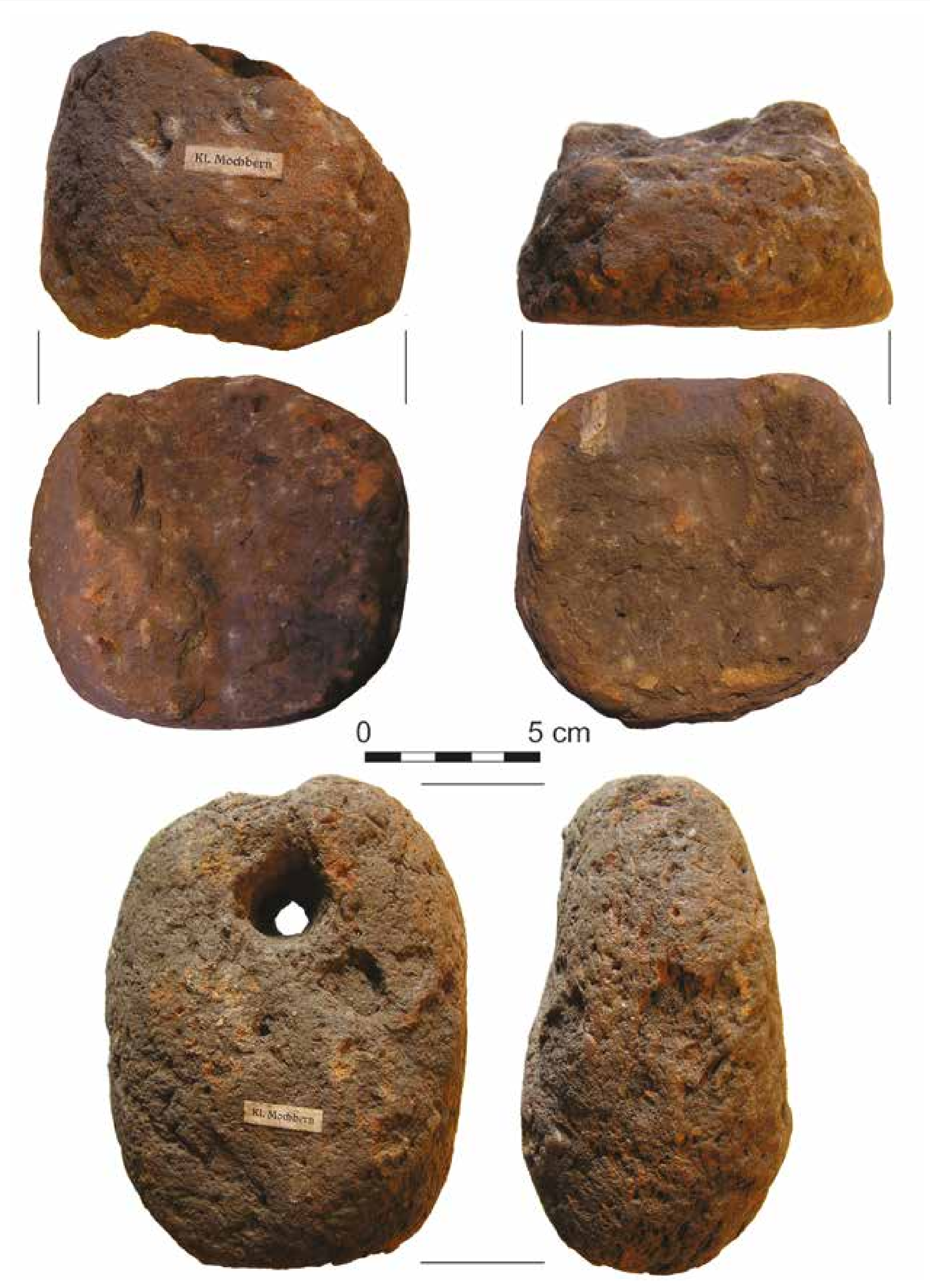

Fig. 6. Loom weights from Feature 5 in Wrocław-Muchobór Mały (*Klein Mochbern*) (photo by J. E. Markiewicz).

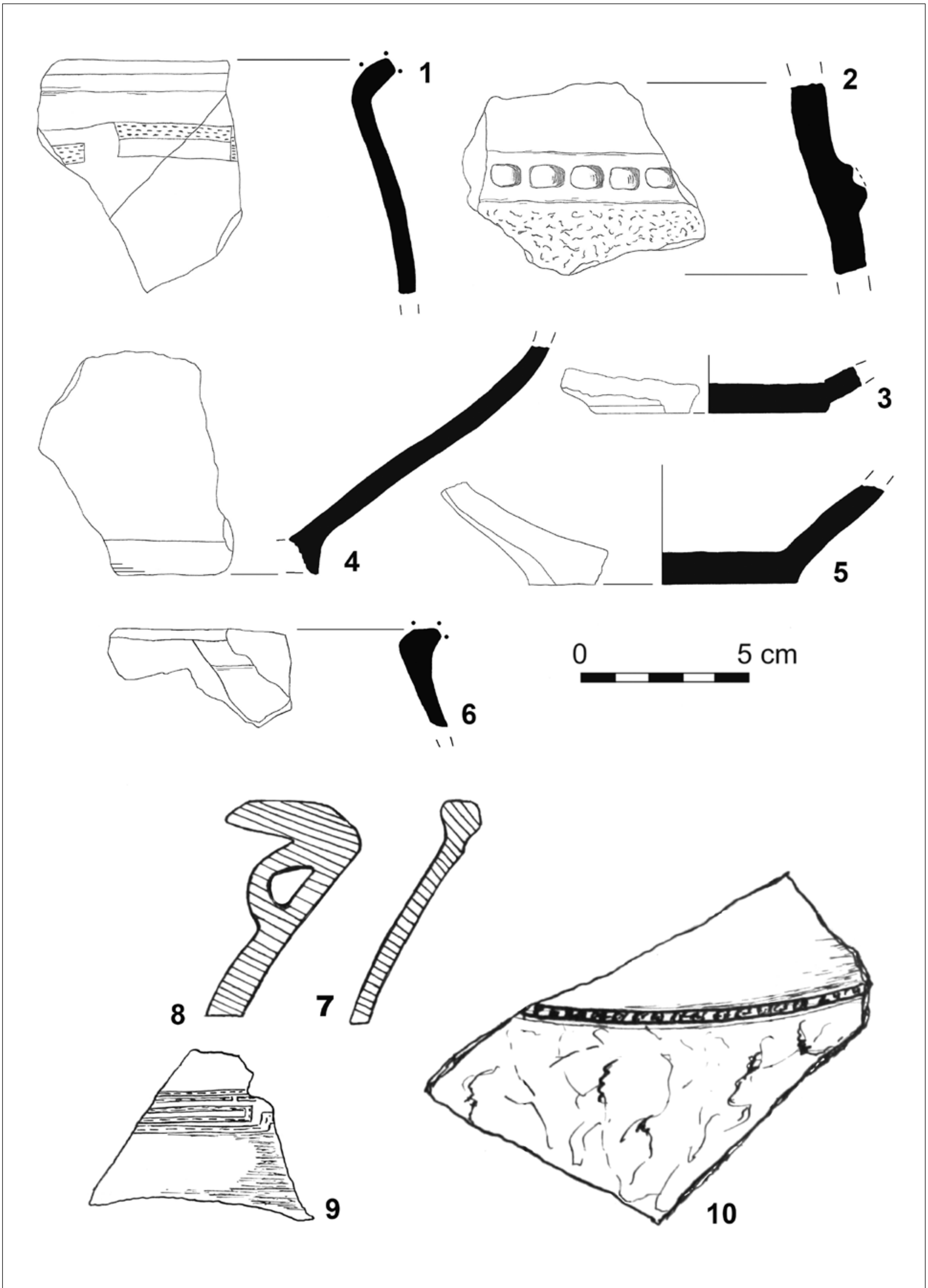

Fig. 7. Potsherds from Feature 5 in Wrocław-Muchobór Mały (*Klein Mochbern*): 1–6 drawn by A. Dołbizno and J. E. Markiewicz; 7–10 after sketches from museum inventory book (MMW-MA, 1129:27, 1131:27, and 1134:27).

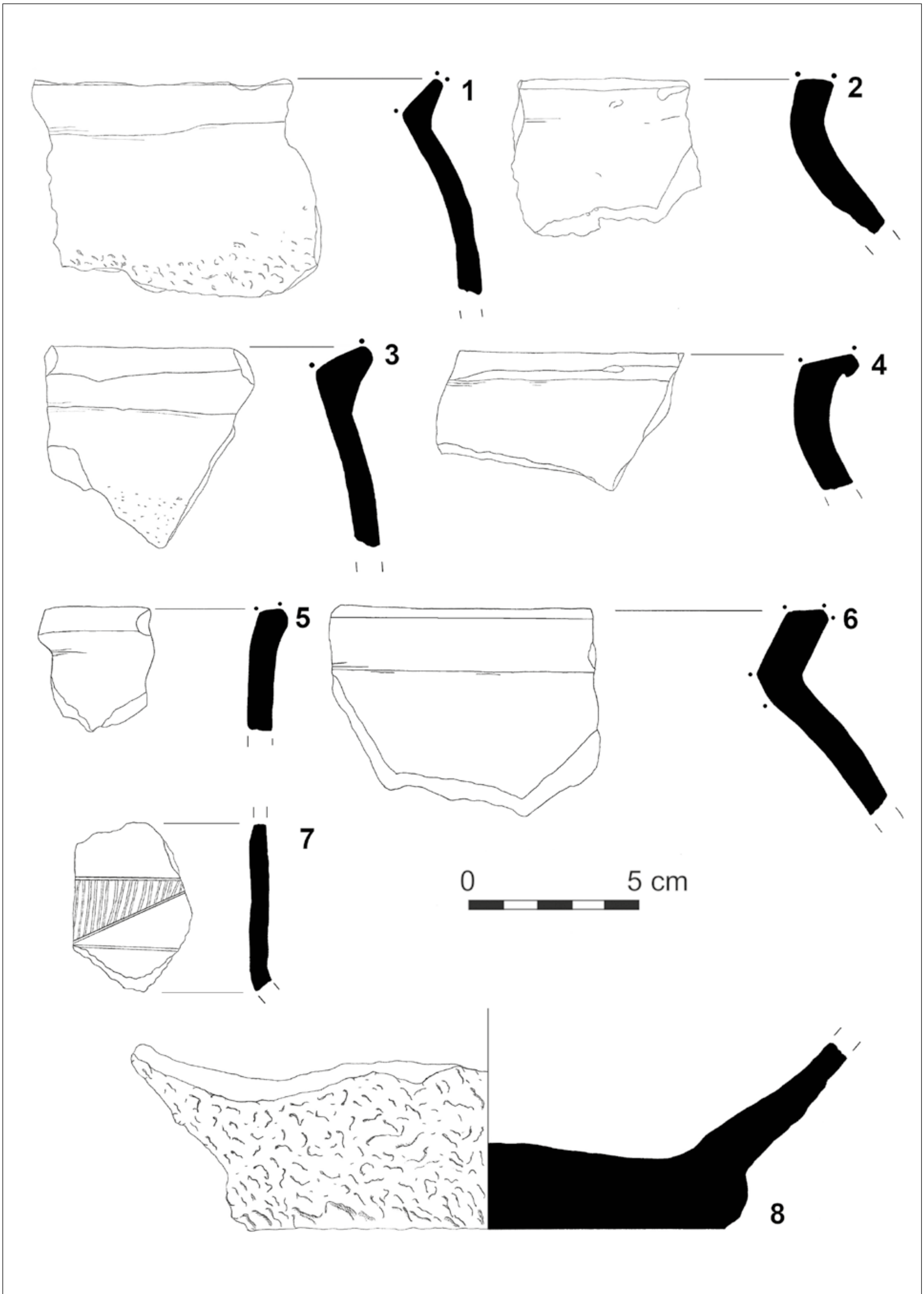

Fig. 8. Potsherds from the cultural layer in Wrocław-Muchobór Mały (*Klein Mochbern*) (drawing by A. Dołbizno and J. E. Markiewicz).

Age. However, the Mötschwil-type fibula from Feature 6 might help narrow the chronology down. Such fibulae are characteristic of Stage LT C2, which corresponds with final Stage A1 and initial Stage A2 of the late pre-Roman Iron Age or Stage A1b, according to the recent interpretation by M. Grygiel. [8]

Wrocław-Muchobór Wielki

Remains of the pre-Roman Iron Age settlement in Wrocław-Muchobór Wielki are located only ca. 1 km west of the already discussed Site 1 in Wrocław-Muchobór Mały, on the left bank of the Kasina stream, Ślęza's left tributary (Fig. 3). The site stretches across the border between the ARP (Archaeological Record of Poland) districts of Wrocław-Muchobór Wielki and Wrocław-Żerniki. Thus, Site 1 in Wrocław-Żerniki is identical to Site 1 in Wrocław-Muchobór Wielki. The excavations conducted in 2014 revealed traces of prehistoric and historic settlement from the Neolithic to the Middle Ages. Only 25 features could be dated to the early stages of the late pre-Roman Iron Age.[9] Here, we shall discuss only one of the features of particular significance for our argument.

Feature 649 had an almost circular (1.1 x 1.2 m) ground plan and was 0.6 m deep (Fig. 9: 1). It contained an assemblage of 88 potsherds, of which only one was smoothed and fired in reduction conditions (Fig. 11: 2). Approximately 30% were roughened, and the rest unsmoothed. What makes the feature special is that – apart from the sherds and a cattle bone[10] – it yielded a copper-alloy Mötschwil-type fibula (Fig. 9: 2). The preserved length of the specimen is 7.7 cm, and the width of the four-coiled spring is ca. 1.6 cm. The bow has an almost D-shaped cross-section and is mildly arched. Its surface is almost undamaged and covered with a green patina. The fibula misses the foot part, of which only the terminal section and the ring-shaped collar around the bow are preserved.

Even though the state of preservation of the pottery assemblage from the site was generally poor, the discussed feature produced a particularly miserably preserved collection of sherds, significantly impeding our interpretative capability. We classified four vessels as pots (Figs. 10: 1–2, 4; 11:1), three as bowls (Fig. 10: 3; 11: 2, 5), and two as cups (Fig. 11: 4, 6). Except for one inverted rim of a hemispherical bowl (Fig. 11: 5), all of the recorded rims were thickened and everted (Figs. 10: 1–2; 11: 3), and one additionally featured three facets (Fig. 11: 2). One of the pots had a stub of a handle (Fig. 11: 1), originally likely X-shaped and ca. 1.3 cm wide in its narrowest point. We observed fine and medium grains of mineral temper in all the vessels. Such pottery style is traditionally associated with advanced Stage A1 and Stage A2 of the late pre-Roman Iron Age. However, other features from the same settlement phase produced a few vessels displaying subtle stylistic traits linking them to the Jastorf tradition, such as the diagonally everted, relatively broad rims with facets on their inner side, large, band-shaped handles and bottom parts of the bodies shaped as truncated cones (Fig. 12). These elements would pull the chronology back to Stage A1 rather than push it forward into the advanced Stage A2.

At the same time, the dating of the Mötschwil-type fibula would situate Feature 649 in Stage LT C2 or pre-Roman Iron Age A1b, as understood by M. Grygiel.[11]

Wilczków (former *Wiltschau/Herdhausen*)

Excavations by a sand/gravel pit in Wilczków, Site 2 (Fig. 13), started at least as early as 1927 and continued into the 1930s. Information on the archaeological excavations and finds from *Wiltschau* (renamed *Herdhausen* in 1937) is available in the Study Archives (Archiwum Naukowe) and museum inventories of the Archaeological Museum in Wrocław, lists of museum acquisitions published in *Altschlesien*,[12] and a handful of pre-war publications.[13]

Finds from the late pre-Roman Iron Age were discovered during excavation campaigns conducted from 1927 to 1931 by Kurt Tackenberg, Georg Raschke, Wilhelm Hoffmann, Werner Boege, and Lothar von Zotz (Fig. 14). An overwhelming majority of the features recorded at the site were inhumation graves of the Únětice Culture. Besides that, a Funnel Beaker settlement phase was identified. The pre-Roman Iron Age features remained unpublished but for a cross-section of Feature 7 recorded in 1931.[14]

Based on the descriptions, maps, drawings and inventory numbers, we identified nine settlement features dated to the late pre-Roman Iron Age: nos. 1, 2 and 4 were discovered in spring 1927 (Fig. 15), no. 5 in autumn 1929, and nos. 1, 2, 5, 6 and 7 in spring 1931 (Fig. 16).

[8] Dąbrowska 1988, 50–62; Grygiel 2018, 91, fig. 48.
[9] Markiewicz 2024.
[10] Abłamowicz 2024, tab. 1.
[11] Grygiel 2018, 91, fig. 48.
[12] Vermehrung… 1931, 99; Vermehrung… 1934, 314.
[13] Fundnachrichte… 1930, 74; Zotz 1932, 127–138; Pescheck 1939, 224, pl. 2: 14–16.
[14] Zotz 1932, fig. 4.

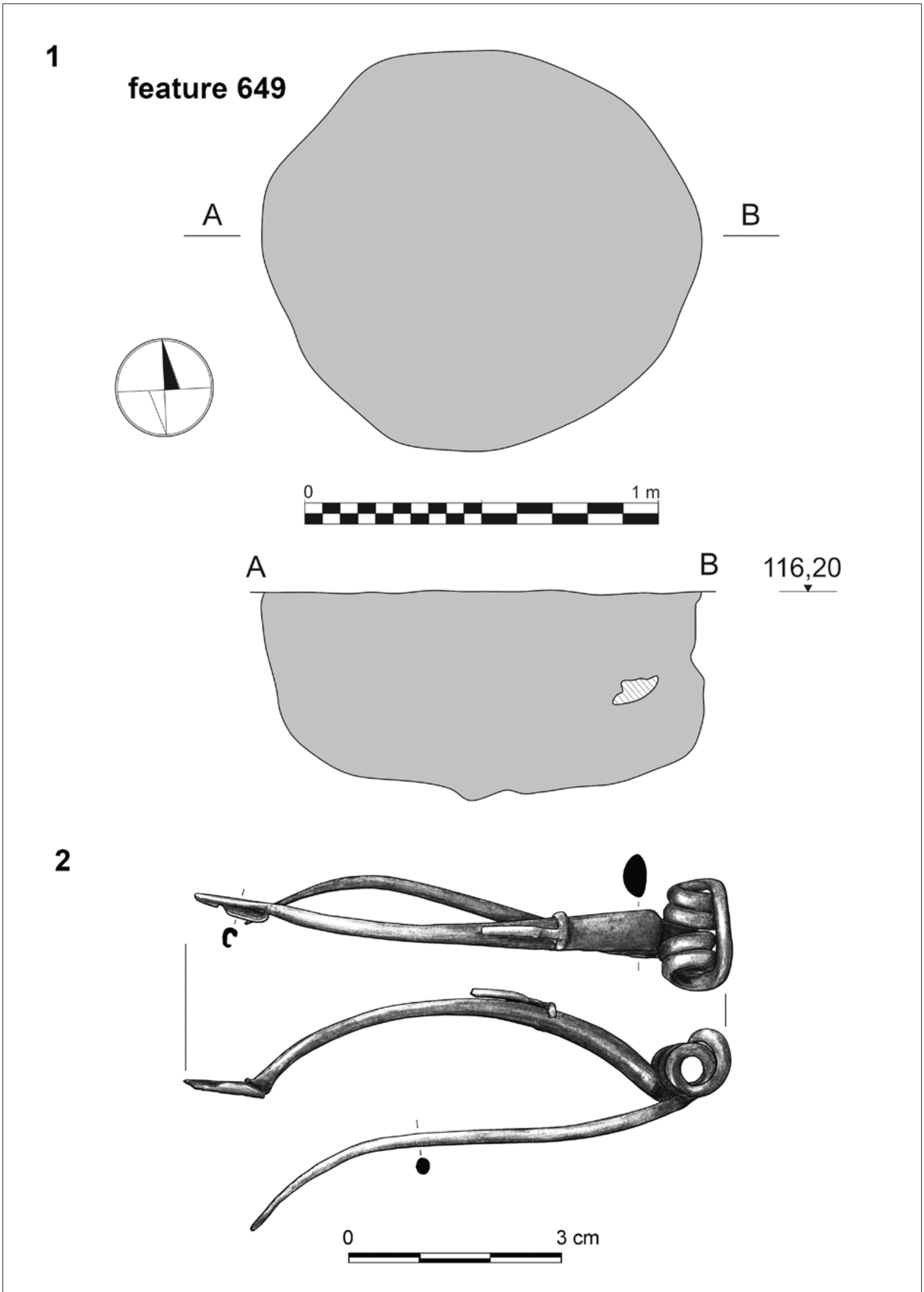

Fig. 9. Feature 649 in Wrocław-Muchobór Wielki: 1 – ground plan and cross-section; 2 – copper-alloy fibula (drawing by N. Lenkow).

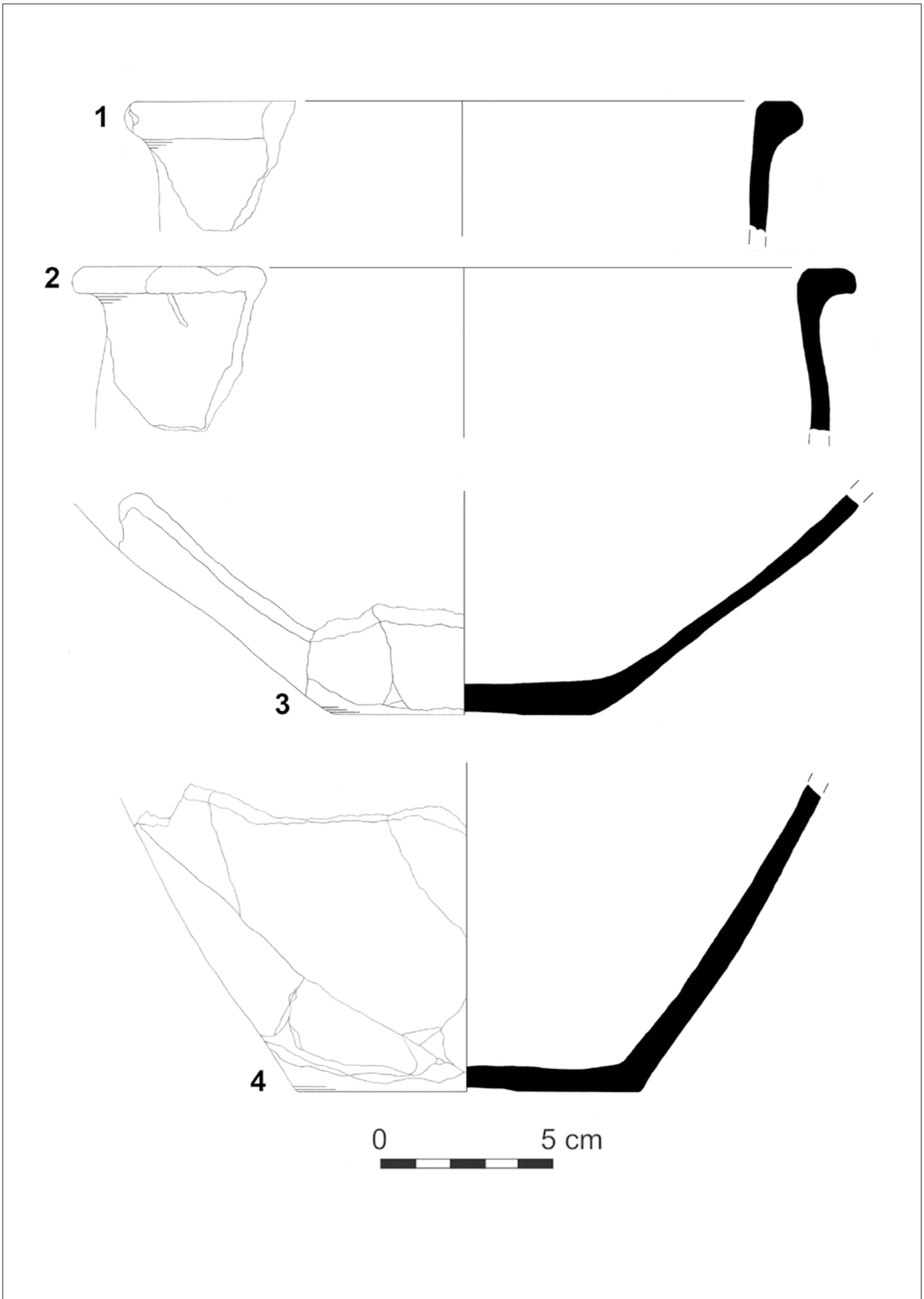

Fig. 10. Potsherds from Feature 649 in Wrocław-Muchobór Wielki (drawing by A. Dołbizno and J. E. Markiewicz).

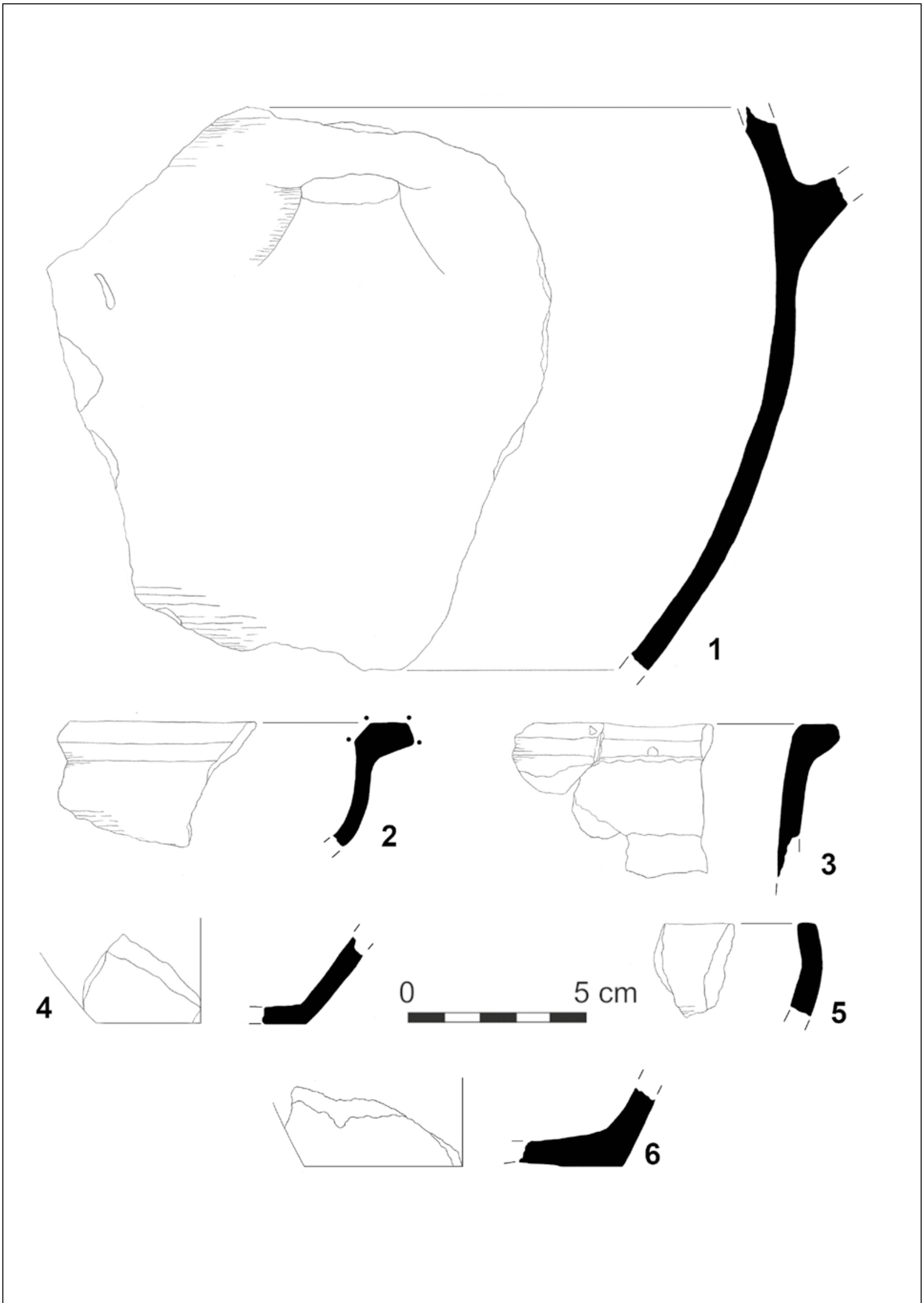

Fig. 11. Potsherds from Feature 649 in Wrocław-Muchobór Wielki (drawing by A. Dołbizno and J. E. Markiewicz).

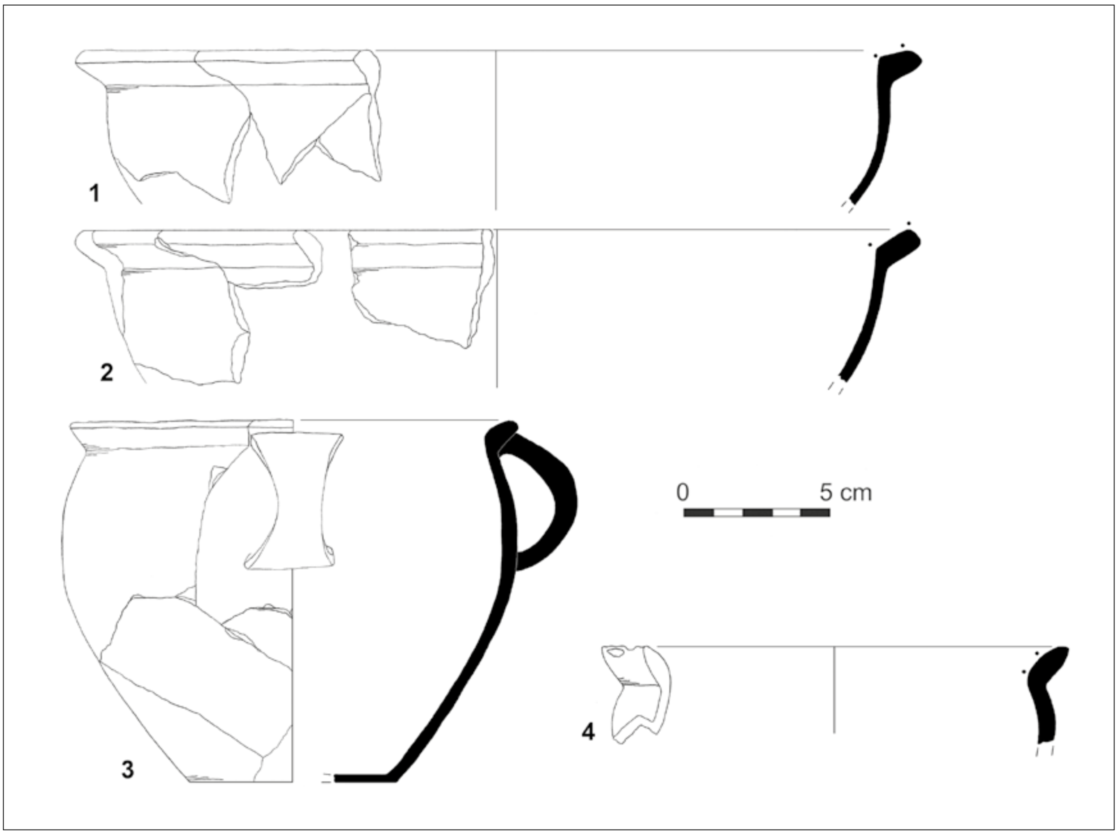

Fig. 12. Selected potsherds from Wrocław-Muchobór Wielki (drawing by A. Dołbizno and J. E. Markiewicz).

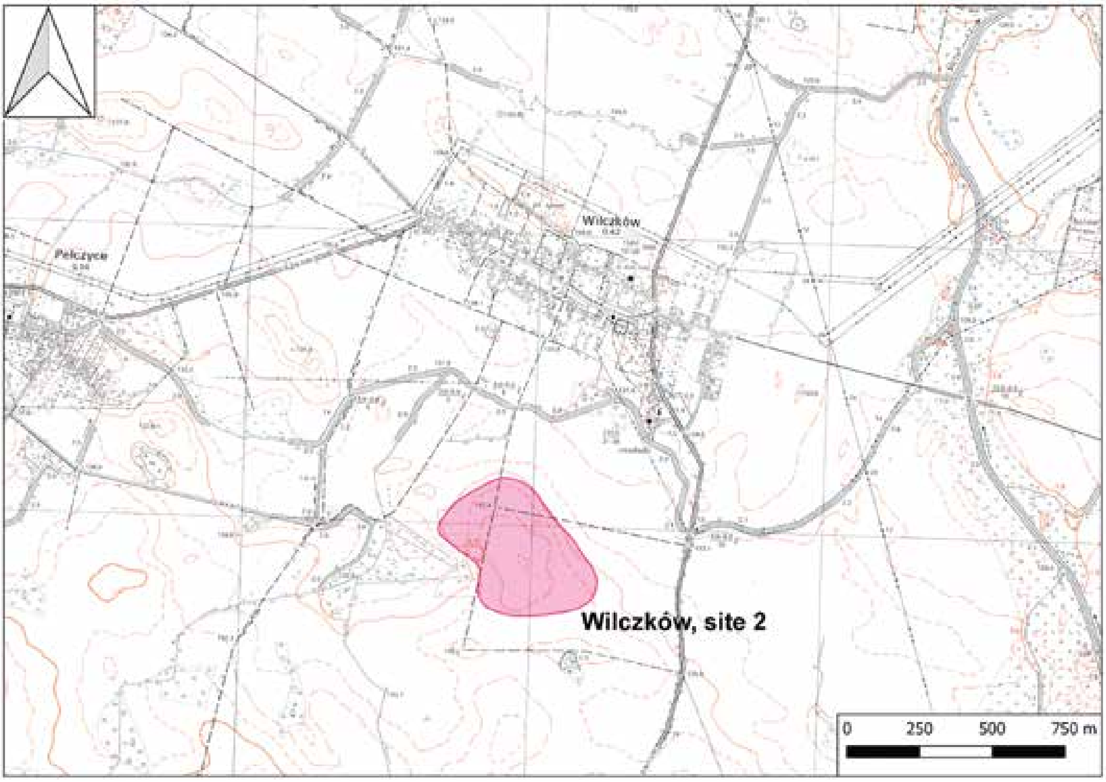

Fig. 13. Location of Site 2 in Wilczków (*Wiltchau*) (compiled by P. Dulęba).

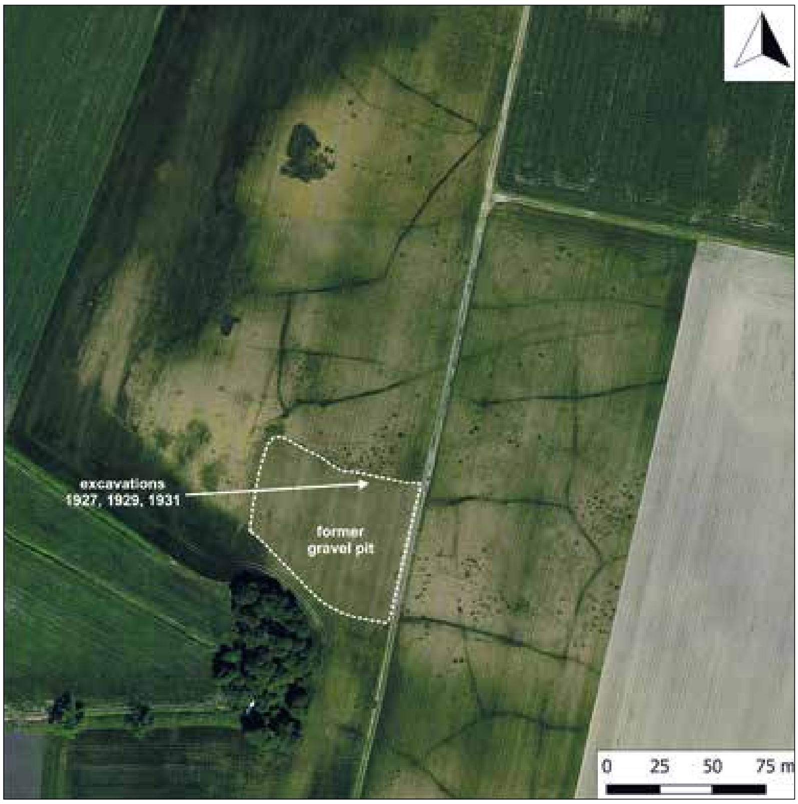

Fig. 14. Location of the former sand and gravel pit in Wilczków (*Wiltchau*), based on open-source satellite imagery (compiled by P. Dulęba).

Feature 1/1927 contained secondarily deposited remains of a destroyed house. However, the feature was not a house, since its ground plan recorded 0.4 m beneath the topsoil surface was described by K. Tackenberg as round, with a diameter of ca. 1.5 m. The fill yielded stones, pieces of daub with wattlework prints – probably parts of the walls (inv. no. 976:27.1), a fully preserved cup (inv. no. 977:27; Fig. 17: 2), a pot (inv. no. 980:27.S1; Fig. 18: 1), a vase/tureen (inv. no. 981:27; Fig. 18: 2), a bottom part of a pot or storage vessel (inv. no. 983:27; Fig. 17: 5), a sizeable three-partite vessel with clearly distinguished neck part and round, roughened body (inv. no. 985:27; Fig. 17: 1) and a rim and neck part of another vessel of this type (inv. no. 982:27; Fig. 19: 1), a fully preserved pot with roughened body (inv. no. 979:27; Fig. 19: 2), and bottom part of a thin-walled, unclassified vessel (inv. no. 983:27; Fig. 19: 3). The feature yielded also burnt barley grains and peas.

Feature 2/1927 was described as a storage pit with a ground-plan diameter of 0.9 m and 0.6 m deep. It was identified 0.3 m below the topsoil surface. It contained a stone, remains of a storage vessel, a rim of a cup/tureen, and a rim of another pot/storage vessel (inv. nos. 988:27 and 989:27; Fig. 20). The latter did not survive in the museum collection, but its sketch was preserved in the inventory book.

Feature 4/1927 was a round pit with a diameter of ca. 0.8 m recorded 0.3 m beneath the topsoil surface. It contained four sherds, two of which were roughened (inv. no. 1001:27), and a horse/cattle molar (inv. no. 1000:27.S4). The sherds are now missing.[15]

Feature 5/1929 was described as a rectangular, 1.4-metre-deep refuse pit. It yielded remains of a fine vase/tureen (inv. no. 1683:30, Fig. 21: 1) made of untempered ceramic mass, ten potsherds from other vessels, of which three were sketched in the inventory book (Fig. 21: 2), as well as animal bones and pieces of antler.

None of the finds from the features excavated in 1931 survived to this date but descriptions, sketches of potsherds (Fig. 22), and excavation plans are available in the archives. Feature 7 was additionally published by Lothar von Zotz.[16]

Feature 1/1931 (Fig. 23) was discovered ca. 0.65 m below the topsoil surface. It had a round ground plan, a diameter of 1.0 m and was 1.0 m deep. The feature

[15] Chronology based on the information from the German scholars' excavation reports.

[16] Zotz 1932, 131–135.

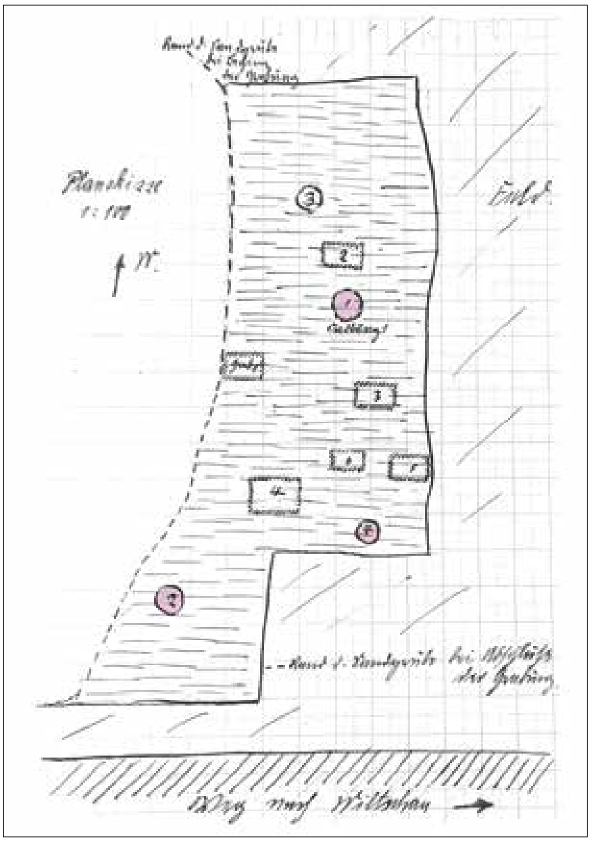

Fig. 15. Excavations in Wilczków (*Wiltchau*) in 1927. Pre-Roman Iron Age features marked in pink (MMW-MA, BN-41-Kl. A, inv. no. 401, p. 10; compiled by J. E. Markiewicz).

contained pieces of daub, granite and quartzite, animal bones (partially burnt), and potsherds (Fig. 22: 1).

Feature 2/1931 (Fig. 24) was identified 0.5 m below the topsoil surface, but sherds also occurred in the cultural layer above this level. Its depth reached 0.8 m. The cultural layer and the fill yielded several stones of varying sizes. Between them, substantial quantities of burnt animal bones and small pieces of burnt wood and daub were deposited. This led the excavator to suggest that the feature should be interpreted as a hearth. Pottery sherds occurred only in the top part of the feature. The inventory book from 1931 mentions nine sherds fired in oxidation conditions, both polished and roughened, among which remains of a bowl-type vessel were identified. It also includes two profile sketches of the rims (Fig. 22: 2), which were everted but not thickened. Such rims occurred in the late pre-Roman Iron Age but might also have an earlier or later provenance. The scarcity of the available information makes the chronology of the feature uncertain.

Feature 5/1931 (Fig. 25) was, upon its discovery, partially destroyed by the sandpit. Its top was recorded at 0.5 and bottom at 0.8 m below the topsoil surface. The feature contained potsherds (Fig. 22: 3), two of which were parts of a large storage vessel, and animal bones, including a deer phalange. In the direct neighbourhood of the feature, a trace of a horizontal timber beam was recorded, and beneath the feature, a few posthole traces were found. The outline and size of the feature's ground plan suggest it was originally a pit house.

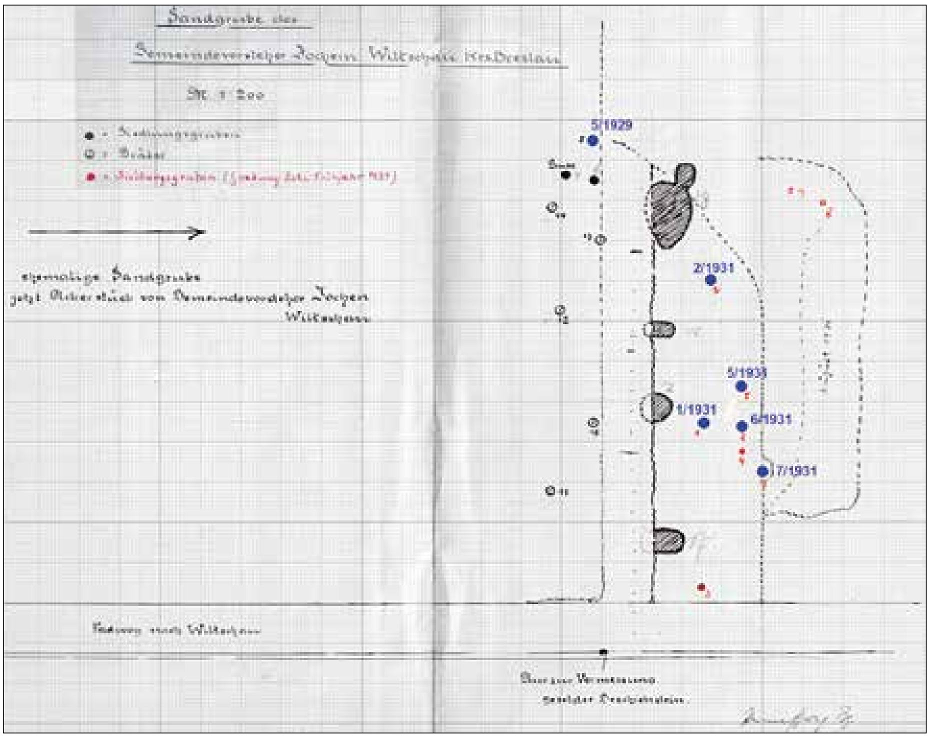

Fig. 16. Excavations in Wilczków (*Wiltchau*) in 1929-1931. Pre-Roman Iron Age features marked in blue (MMW-MA, BN-41-Kl. A, inv. no. 401, p. 27; compiled by J. E. Markiewicz).

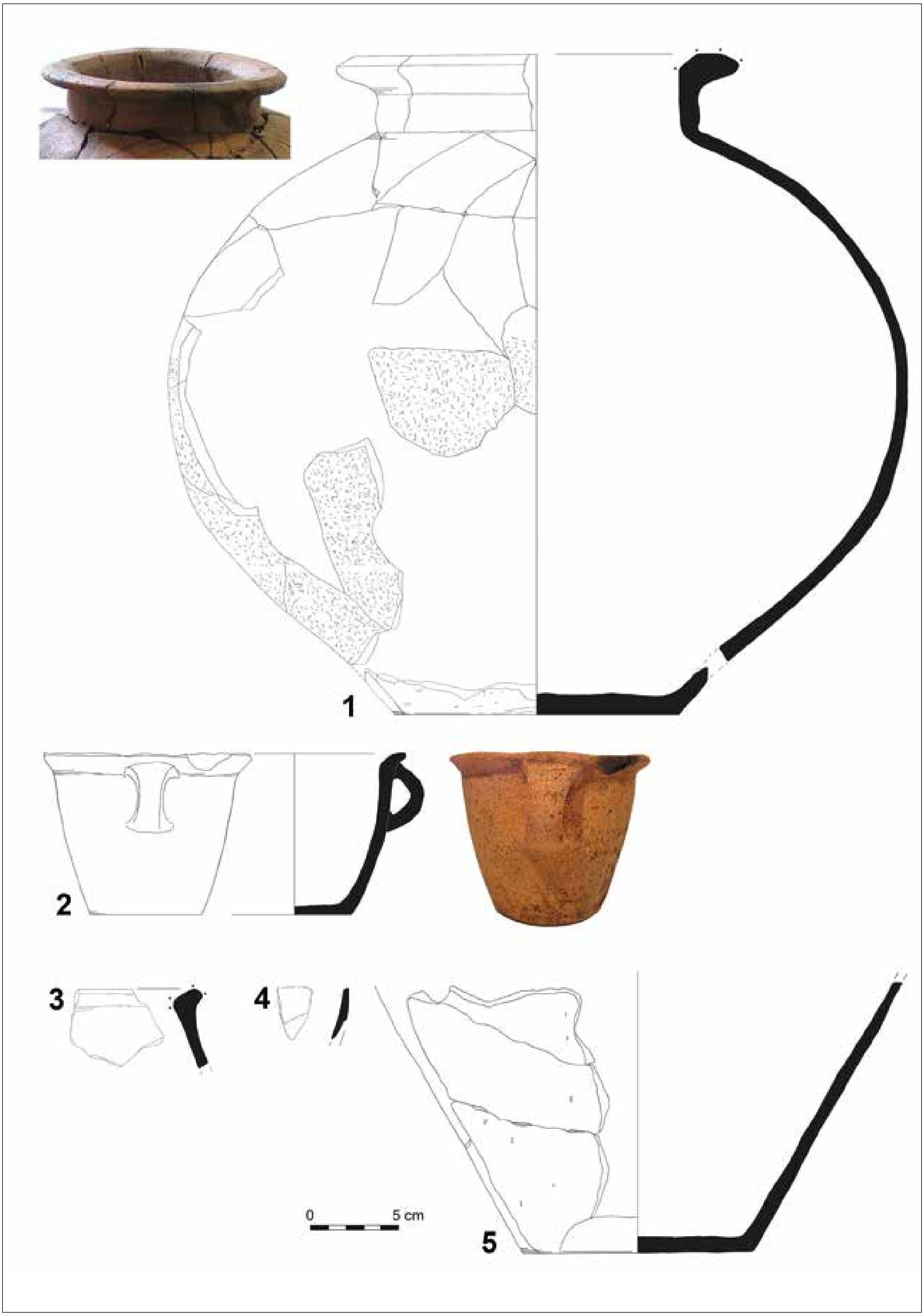

Fig. 17. Pottery from Feature 1/1927 in Wilczków (*Wiltchau*); (drawing and photo by A. Dołbizno).

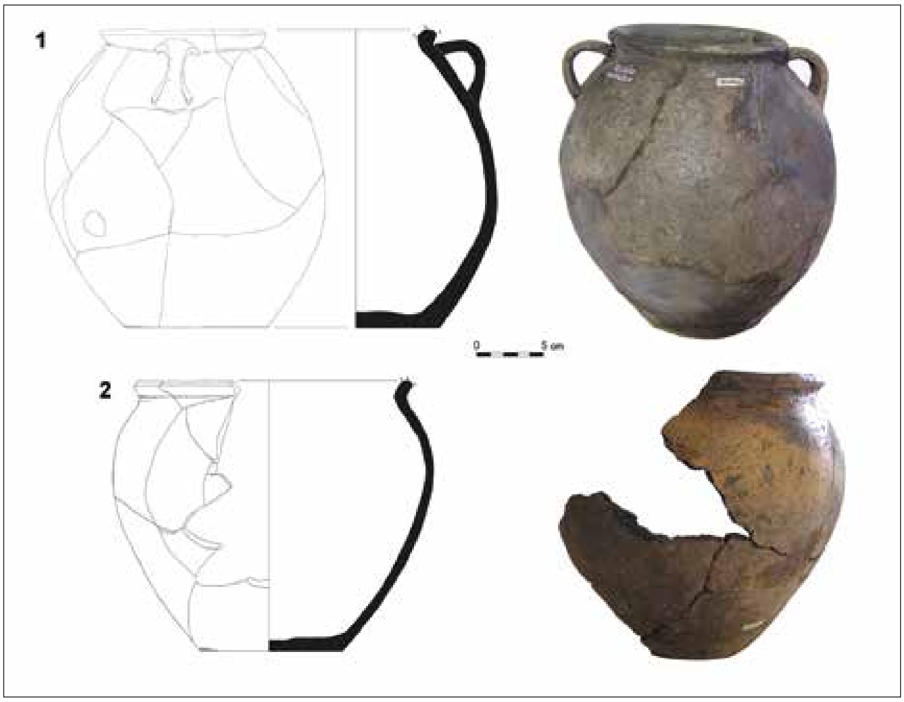

Fig. 18. Pottery from Feature 1/1927 in Wilczków (*Wiltchau*); (drawing by A. Dołbizno, photo by J. E. Markiewicz).

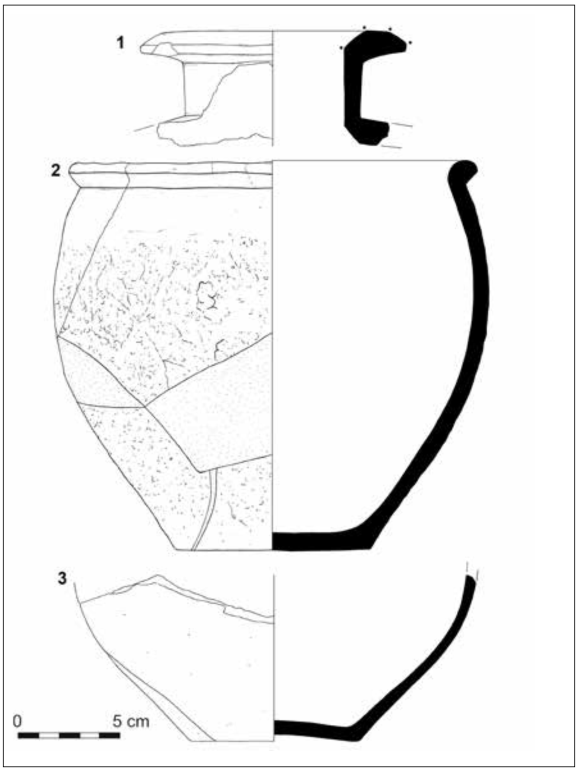

Fig. 19. Pottery from Feature 1/1927 in Wilczków (*Wiltchau*) (drawing by A. Pyzik).

Feature 6/1931 (Fig. 25) was a round pit similar to Feature 1/1931. It contained four roughened potsherds fired in oxidation conditions, animal bones and pieces of daub.[17]

Feature 7 /1931 (Fig. 26) came to light 0.5 m below the topsoil surface. It had an almost circular ground plan with a rectangular annexe, was ca. 1.0 m deep and featured a flat bottom. Its top part contained a poorly preserved skeleton of an adolescent individual covered with six stones, each with a diameter of ca. 0.1 m. A cattle phalange was recorded near their chest, and a cattle jaw was found at their feet. As it turned out later, cattle bones were scattered throughout the fill. Directly beneath the burial, two late pre-Roman Iron Age sherds were found. The archaeologists discovered another burial under the bottom of the pit, which reached 1.5 m in depth. The buried individual was most probably a newborn, and the burial was furnished with a partially preserved small cup (Dąbrowska's Type I.1)[18] with a thickened and everted rim and a half of iron tweezers (Fig. 27). The tweezers reportedly fell apart upon the removal from the pit. The inventory book lists ten potsherds from the feature – both polished and roughened – and the cup from the baby's burial. The drawing of the cup was published by von Zotz (Fig. 27) and sketched in the inventory book (Fig. 22: 4). These drawings differ, so one of them is likely inaccurate.

[17] Chronology based on information from the German scholars' excavation reports.

[18] Dąbrowska 1973, 500.

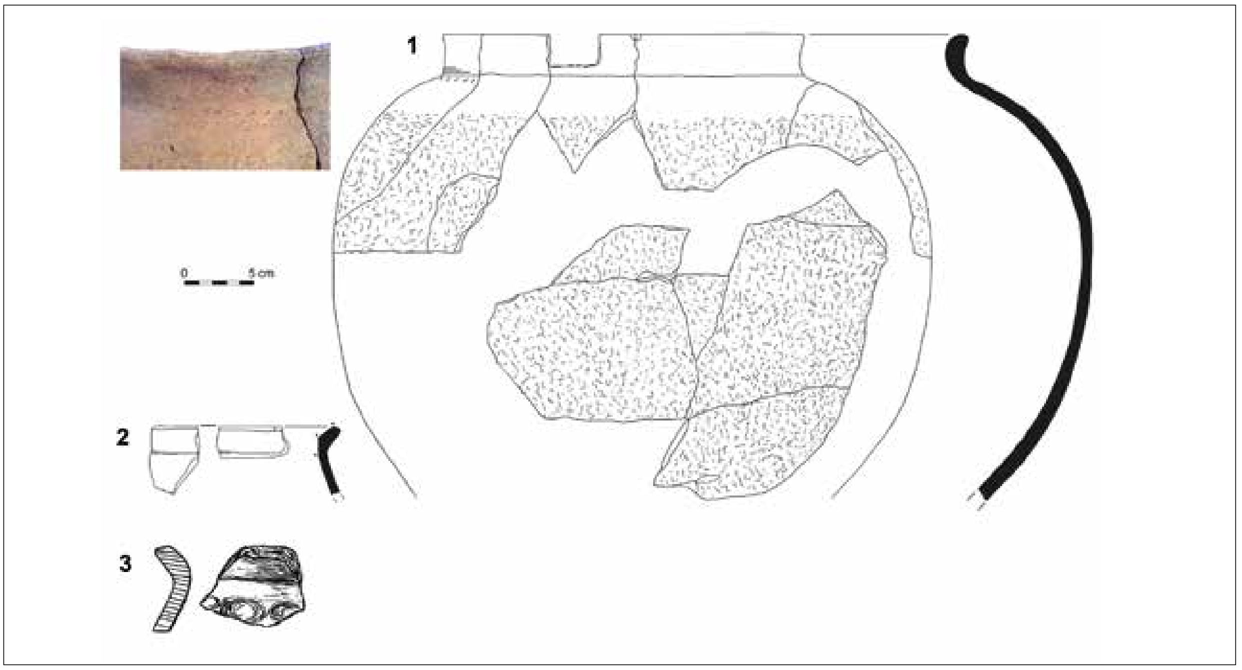

Fig. 20. Pottery from Feature 2/1927 in Wilczków (*Wiltchau*). 1–2 vessels preserved in the museal collection; 3 – sketches from the inventory book (MMW-MA, 989:27; drawing by A. Dołbizno, photo by J. E. Markiewicz).

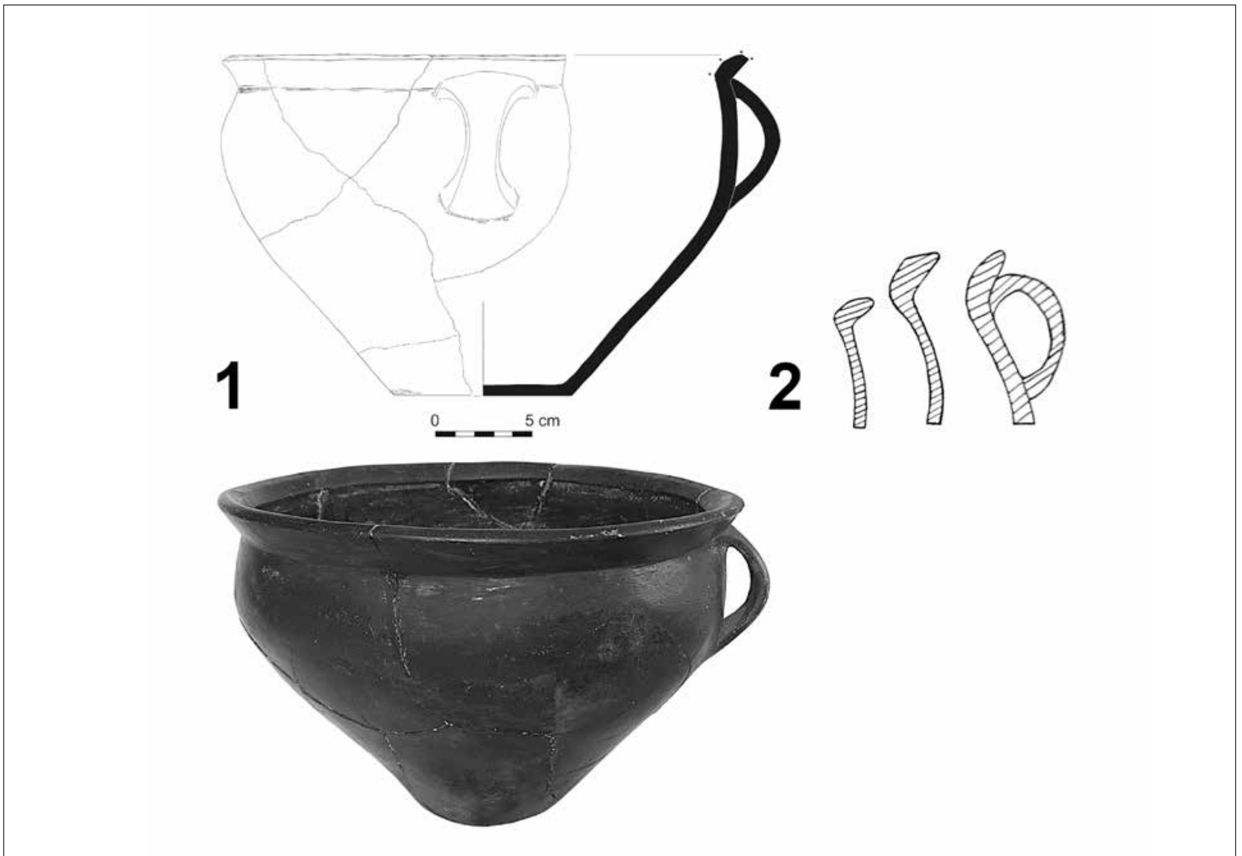

Fig. 21. Vessel from Feature 5/1929 in Wilczków (*Wiltchau*): 1 – vessel preserved in the museum collection; 2 – profile sketches from the inventory book (MMW-MA, 1685:30; drawing by A. Dołbizno, photo by J. E. Markiewicz).

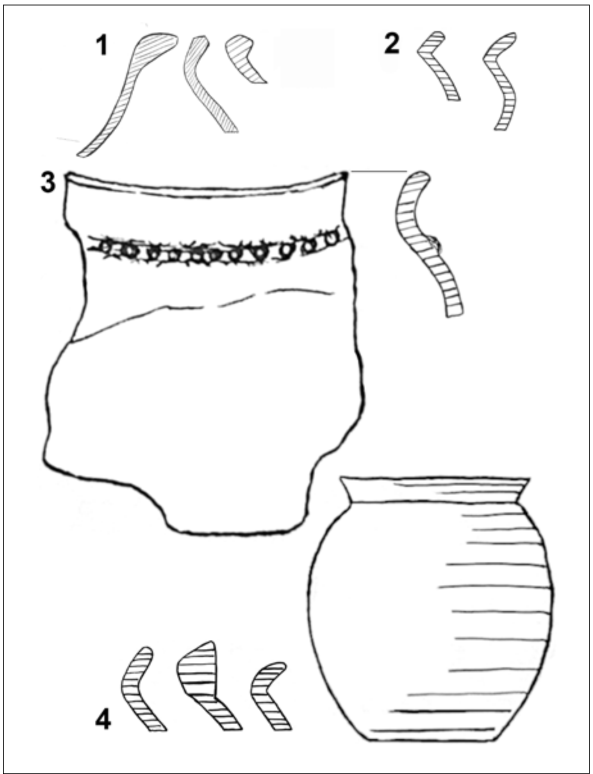

Fig. 22. Wilczków (*Wiltchau*). Sketches from the inventory book (MMW-MA, 1722, 1726, 1733, 1741, and 1742:31): 1 – Feature 1/1931; 2 – Feature 2/1931; 3 – Feature 5/1931; 4 – Feature 7/1931 (compiled by J. E. Markiewicz).

Unlike in the previously discussed sites, the preserved assemblage of ceramic finds from Wilczków made it possible to reconstruct eight vessel forms. In five further vessels, only the rim or base parts survived.

Feature 1/1927 contained a double-handled vessel (Fig. 18: 1), a vase (Fig. 18: 2), a jug resembling an inverted pear-shaped vessel (Fig. 17: 1), a cup (Fig. 17: 2), and a pot (Fig. 19: 2). Unclassifiable rims of tableware vessels (Figs. 17: 3–4), a rim of an inverted-pear shaped jug (Fig. 19: 1), a bottom part of a pot (Fig. 17: 5), and a bottom part of a tableware vessel (Fig 19: 3) also occurred. The double-handled vessel lacked the neck part and featured two facets on the rim. It might be classified as Dąbrowska's Type VI.2 bulging vessel[19] or Machajewski and Pietrzak's bi-partite B.II pot.[20] Such vessels occur in contexts dated to stages A1 and A2 of the late pre-Roman Iron Age, including, for instance, a cemetery in Kamieńczyk[21] and settlement sites in Poznań-Nowe Miasto[22] and Smólsk[23]. The vase and the pot have only slightly thickened, everted rims, the former with two facets. They both fall into Dąbrowska's Category VI – bulging vessels or VII – vessels with rounded bodies.[24] In the system developed for settlement finds from Greater Poland, such vessels are classified as bi-partite pots of groups B.I and B.II, associated with the early stages of the late pre-Roman Iron Age.[25] Similar specimens were recorded in assemblages from stages A1–A2 of the late pre-Roman Iron Age.[26] The most unusual vessel in the assemblage is the large tri-partite jug with a thickened, everted rim with four facets, of which one was located on the inner side of the rim. The neck is cylindrical, and the handle, if present, was not preserved. Unlike in the inverted pear and pear-shaped jugs, the vessel's widest point was in the middle of its body. Its width (42 cm) exceeded its reconstructed height (37 cm). What is also untypical for jugs is that the specimen was roughened almost all the way from the shoulder down – except for a part around the base, ca. 3 cm wide. Jars with distinguished neck parts and prominent bodies with a maximum diameter in their mid-height were widely used in Jutland, where S. Hvass classified them as jars of Group V.[27] In Hodde, a similar specimen but with a thin rim was dated to Becker's early Phase IIIa,[28] which corresponds with Phase IIA according to Martens[29] and Stage A1 of the late pre-Roman Iron Age. However, the closest matches might be found in northern Jutland. They occurred in grave assemblages in Kraghede and Vogn.[30] In the latter, they were dated with Kostrzewski's K-type fibulae to Martens' Phase IIB1 synchronised with Stage A2 of the late pre-Roman Iron Age.[31] A formally similar jar was also found in Grave 323 in Kamieńczyk[32] with Kostrzewski's K-type fibula, which would date the assemblage to Phase A2 of the late pre-Roman Iron Age. However, the jug from Kamieńczyk was smaller (max. diameter of ca. 32 cm), smooth, with a decorated shoulder and only two facets on the top and outer side of the rim. The last fully preserved vessel from Feature 1 was a small cup with a slightly rounded body, X-shaped handle and everted, unthickened rim. Its surface was heavily weathered, so it is difficult to determine whether any facets were present. It might be

[19] Dąbrowska 1973, 504; Dąbrowska 1997, 103.
[20] Machajewski, Pietrzak 2004, 89–95.
[21] Dąbrowska 1997, pl. CXLVI: 1
[22] Machajewski, Pietrzak 2008b, pl. 30: 7.
[23] Kot, Piotrowska 2014, fig. 13: 1
[24] Dąbrowska 1973, 505–506.
[25] Machajewski, Pietrzak 2004, 89–95.
[26] e.g., Dąbrowska 1997, pls. CLXVIII: 11, CLXXIII: 4; Machajewski, Pietrzak 2008b, pl. 11: 7.
[27] Hvass 1985, 149–150.
[28] Hvass 1985, fig. 125, pl. 142: d.
[29] Martens 1996, figs. 12–14.
[30] Martens 1997, figs. 8, 17.
[31] Martens 1997, fig. 16.
[32] Dąbrowska 1997, pl. CXLVIII.

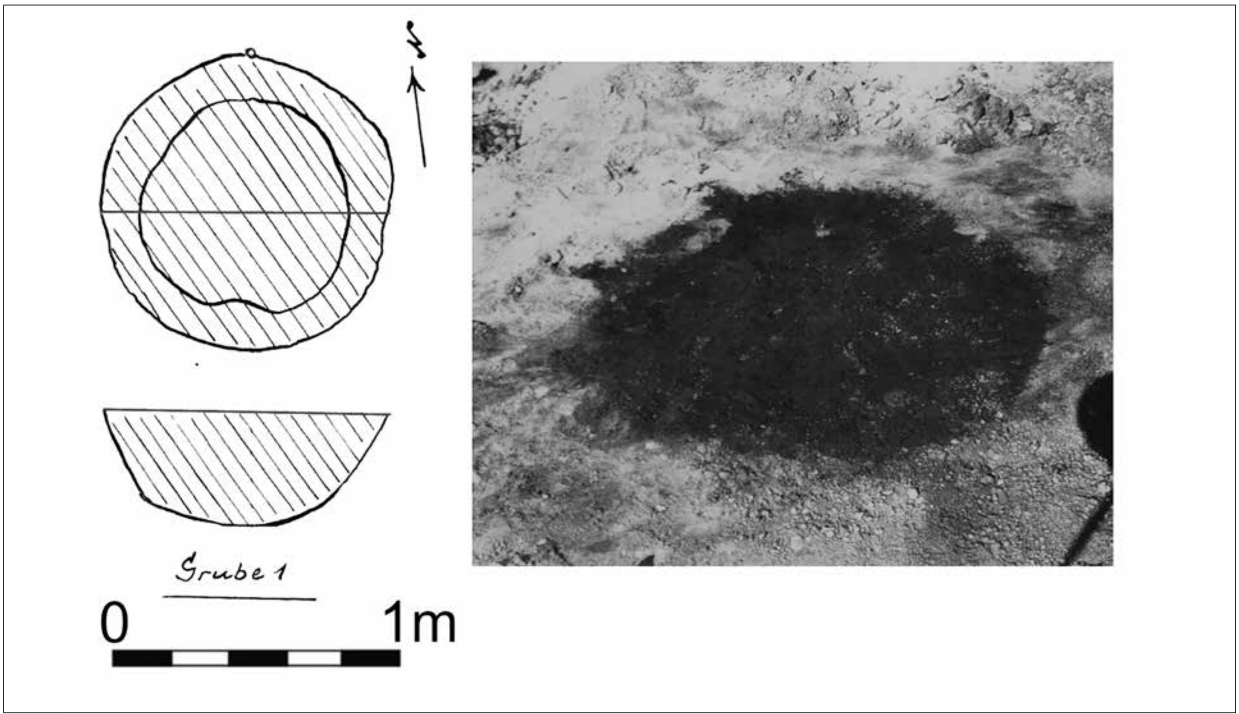

Fig. 23. Wilczków (*Wiltchau*). Ground plan and cross-section of Feature 1/1931 (MMW-MA, BN-41-Kl. A, inv. no. 401, p. 35; compiled by J. E. Markiewicz).

potentially classified as Dąbrowska's Type I.1 cup,[33] but it differs from the Przeworsk cups in terms of the rim shape. More accurate matches might again be found in Jutland, where they occur in early Becker's Phase IIIa.[34]

Feature 2/1927 yielded a faceted tableware rim, which could not be classified (Fig. 22: 2), a rim of a pot/storage vessel decorated with fingertip impressions (Fig. 22: 3), and an almost entirely preserved large pot (Fig. 22: 1). The pot has a slightly thickened, rounded, mildly everted rim and a round body with a roughened surface. It lacks the neck part. Such vessels typically occur in settlement contexts across the North European Plain. A close match was recorded in Poznań-Nowe Miasto, Site 278,[35] where it was classified as a B.II.2.a vessel. Similar vessels also occurred in Smólsk[36] and Izdebno Kościelne[37]. In these contexts, they might be dated to the early stages of the late pre-Roman Iron Age. This is in concert with the chronology of the find from the Przeworsk Culture cemetery in Kamieńczyk,[38] where it occurred with a Kostrzewski's D/E-type fibula. At the same time, further to the north and west, such vessels were found, e.g., at the settlement in Hamburg-Volksdorf, Site 77, which functioned in the final stages of the late pre-Roman Iron Age.[39] Interestingly, the specimen from Wilczków features nail prints just below the rim. They look as if they were accidentally made while joining the rim part with the body and fashioning it. Their size suggests that the person who formed the vessel was a woman or a child.

The only fully preserved vessel from Feature 5 is a vase (rim diameter of 27 cm) with an x-shaped, faceted handle, everted rim with three facets, shoulder located above the vessel's mid-height, and lower part of the body shaped as a truncated cone. It was made of fine, untempered ceramic mass. Vessels of this shape are a variant of Dąbrowska's I.1-type cups, which are typical of the Przeworsk Culture assemblages from stages A1–A2 of the late pre-Roman Iron Age, but they occur in substantial numbers also in the Gubin Group and the late Jastorf contexts. However, as M. Kasiński has observed,[40] specimens with size (and shape!) matching the Wilczków cup occur predominantly in the Gubin Group and central Germany and only exceptionally within the Przeworsk Culture cemeteries in its primary distribution area. Similar vessels come from Grave 5 found in Nowe

[33] For example, Dąbrowska 1997, pls. XIV: 5, XVI: 6, 3.
[34] Hvass 1985, 93–94, pls. 141: f, 145: j–k.
[35] Machajewski, Pietrzak 2008a, pl. 35: 3.
[36] Kot, Piotrowska 2014, fig. 13: 4.
[37] Machajewski, Rozen 2016, pl. 72: 6.
[38] Dąbrowska 1997, pl. XCV: 4.
[39] Bücke 2007, 186–187, pl. 22: 531.
[40] Kasiński 2010, figs. 3–6.

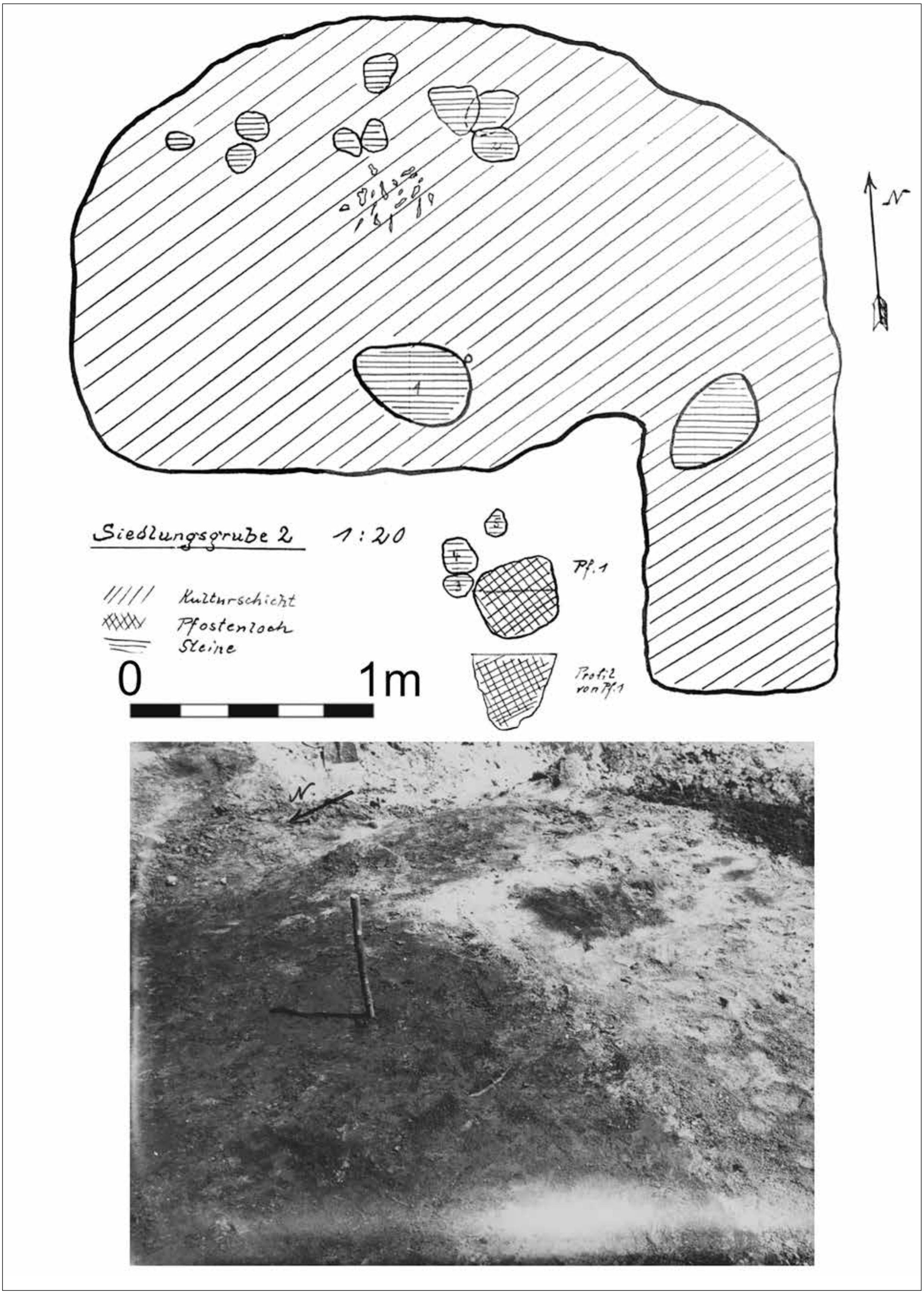

Fig. 24. Wilczków (*Wiltchau*). Ground plan and cross-section of Feature 2/1931 (MMW-MA, BN-41-Kl. A, inv. no. 401, p. 35; compiled by J. E. Markiewicz).

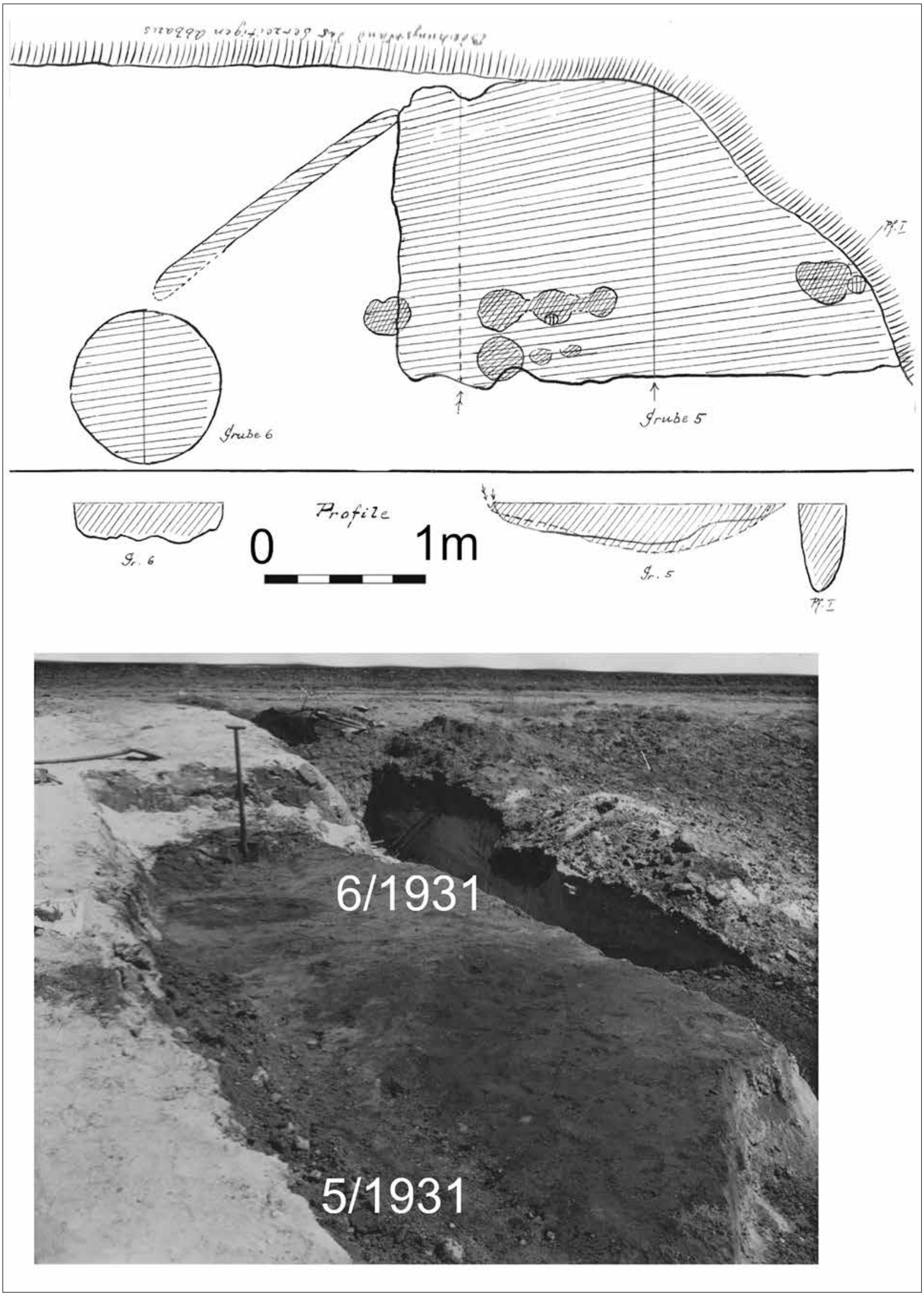

Fig. 25. Wilczków (*Wiltchau*). Ground plans and cross-sections of features 5/1931 and 6/1931 (MMW-MA, BN-41-Kl. A, inv. no. 401, p. 34; compiled by J. E. Markiewicz).

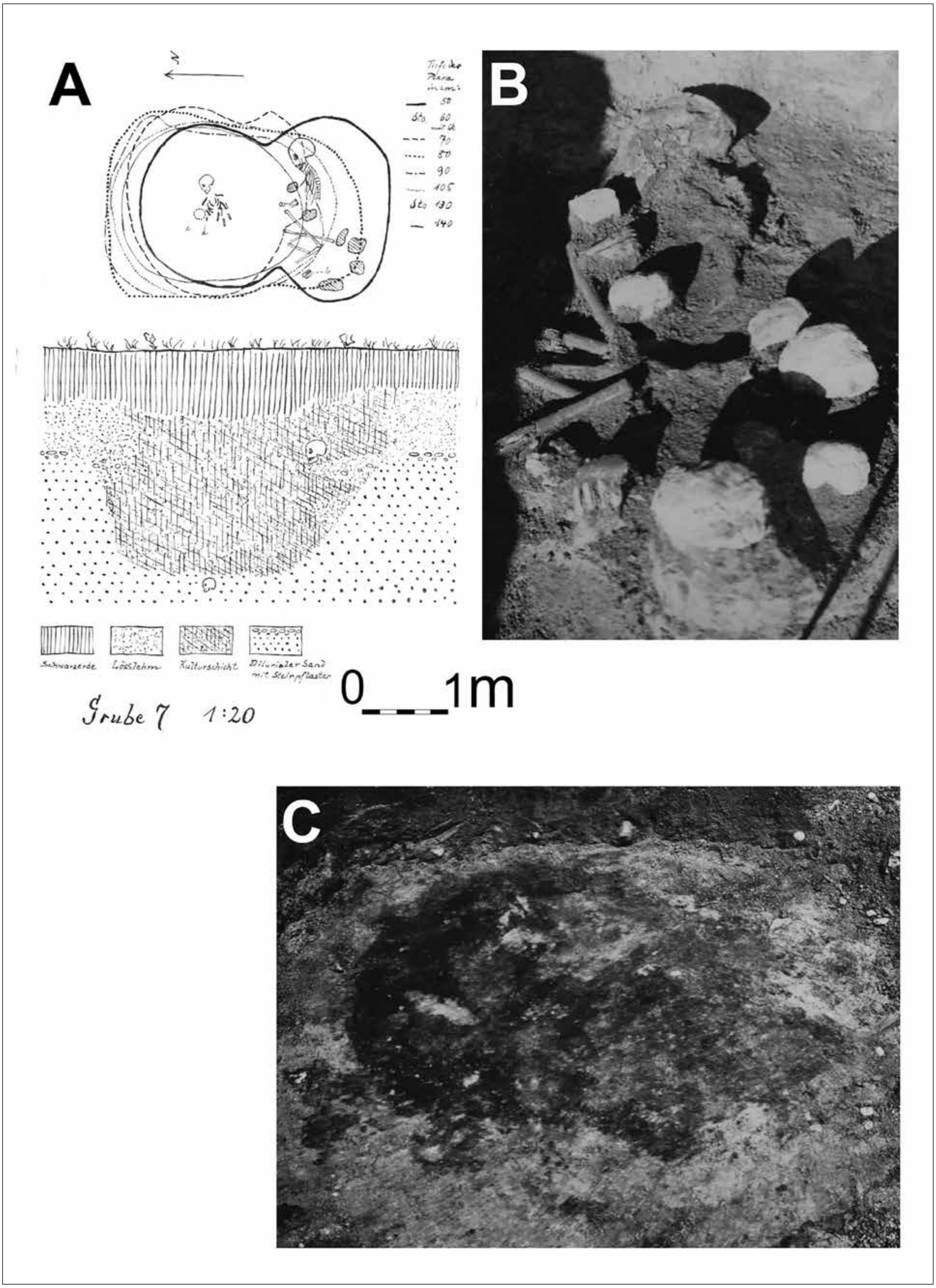

Fig. 26. Wilczków (*Wiltchau*). A – feature outline at various depths and cross-section of Feature 7/1931; B – burial of the adolescent individual; C – feature outline after removing the burial of the adolescent individual (MMW-MA, BN-41-Kl. A, inv. no. 401, no page no.; compiled by J. E. Markiewicz).

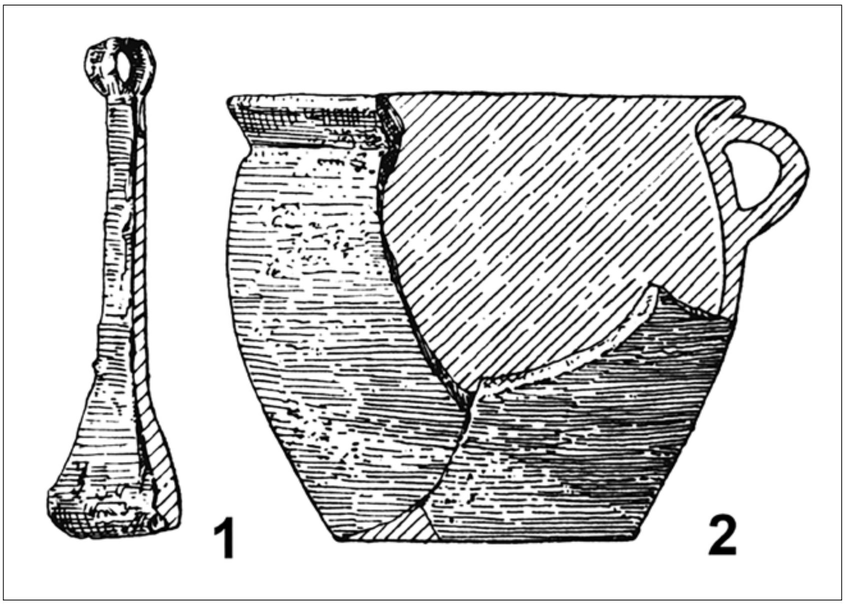

Fig. 27. Wilczków (*Wiltchau*). Grave furnishings from the newborn burial at the bottom of Feature 7/1931. Scale 1:2 (after: von Zotz 1932, fig. 8).

Miasteczko, Nowa Sól district,[41] furnished with a long, iron specimen (ca. 12 cm) of a Gebhard's Group 19 fibula, Grave 45 from Luboszyce, Lubsko district[42] with a damaged iron specimen of Kostrzewski's A-type fibula (with the preserved length of 7 cm, but it must have originally been at least 10 cm). Close matches might also be identified at other sites with Jastorf-type evidence in the Polish Lowland. An almost identical specimen occurred in Grave 158, found at a cemetery in Babi Dół-Borcz[43] dated with a short (ca. 6 cm) B-type iron fibula with knobs on the bow and Kostrzewski's type I iron belt buckle. According to Strobin and Jakubczyk, the burial originated in the early Stage A1 (A1a) of the pre-Roman Iron Age, synchronised most likely with Stage LT C1b. Another matching vessel was recorded in 1912 or 1913 in Czarnków (*villa Ulmenstein*), Czarnków-Trzcianka district, but the find lacks context.[44]

Formal, spatial, and temporal assessment of the finds

The pre-Roman Iron Age vessels from the discussed chronological and spatial scope might be divided into six formal groups: cups, bowls, vases/tureens, jugs, pots, and storage vessels. We distinguished three types of surfaces: polished, unpolished, and roughened/textured. The vessels rarely had any decorations. If present, those were either incised, meander-shaped ornaments (Figs. 7: 1, 9; 8: 7) or bands of fingertip or fingernail impressions, most often placed on clay strips around the vessel shoulders or necks (Figs. 2: 5; 7: 2, 10; 20: 3; 22: 3). As mentioned in the preceding section, the former are traditionally associated with the Przeworsk style, although their variants were present also in earlier Jastorf contexts. The latter occurred on vast areas of the North European Plain, from Jutland to Silesia.

The formal diversity within the discussed vessel categories in the earliest stage of the late pre-Roman Iron Age in Silesia is presented in Figure 28.

Bowls were defined as thin-walled vessels with a rim diameter at least twice as great as their height and usually polished surfaces. Bowls are typically the most frequently recorded vessels at settlement sites from the pre-Roman Iron Age in north-central Europe. The recorded variants include hemispherical bowls with inverted or vertical rims and relatively shallow bowls with everted rims. The latter frequently featured S-shaped profiles, and the rims were additionally thickened and faceted.

Cups might be defined as small tableware vessels (rim diameter up to ca. 15 cm), usually with polished surfaces and thin walls, higher than bowls, typically featuring a handle. The rims in the recorded specimens are almost always everted, frequently thickened and faceted.

Vases/tureens are understood as medium-sized tableware (over ca. 15 cm rim diameter) vessels with thin or medium-thick walls, higher than bowls, usually polished.

[41] Tackenberg 1929, pl. XVI:1–2, fig. 5:1.
[42] Domański 1975, pl. VII: c, d, g.
[43] Strobin, Jakubczyk 2017, 223–238.
[44] Michałowski 2006, 190, fig. 15.

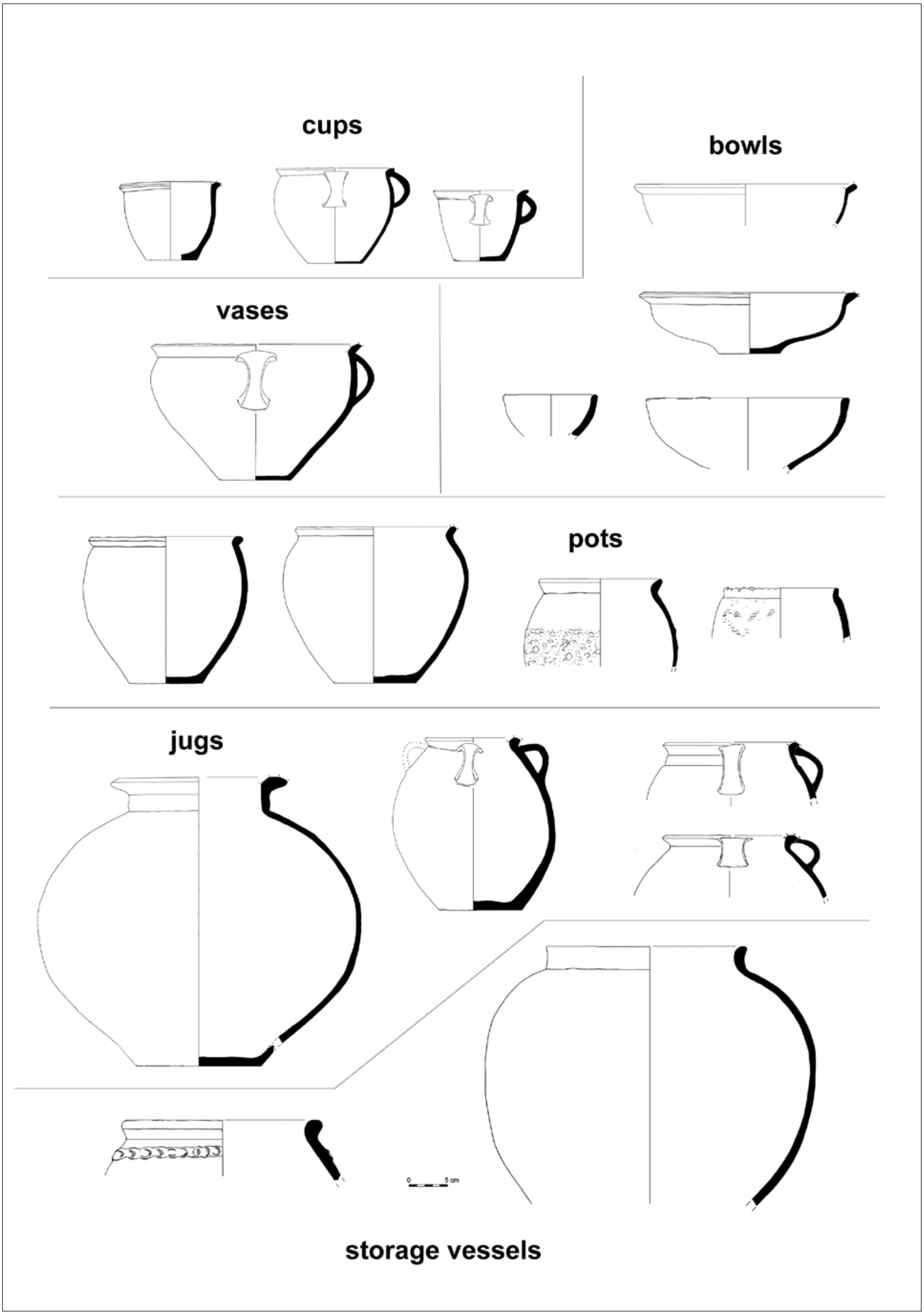

Fig. 28. Main types of Late Pre-Roman Silesian settlement vessels (compiled by P. Dulęba).

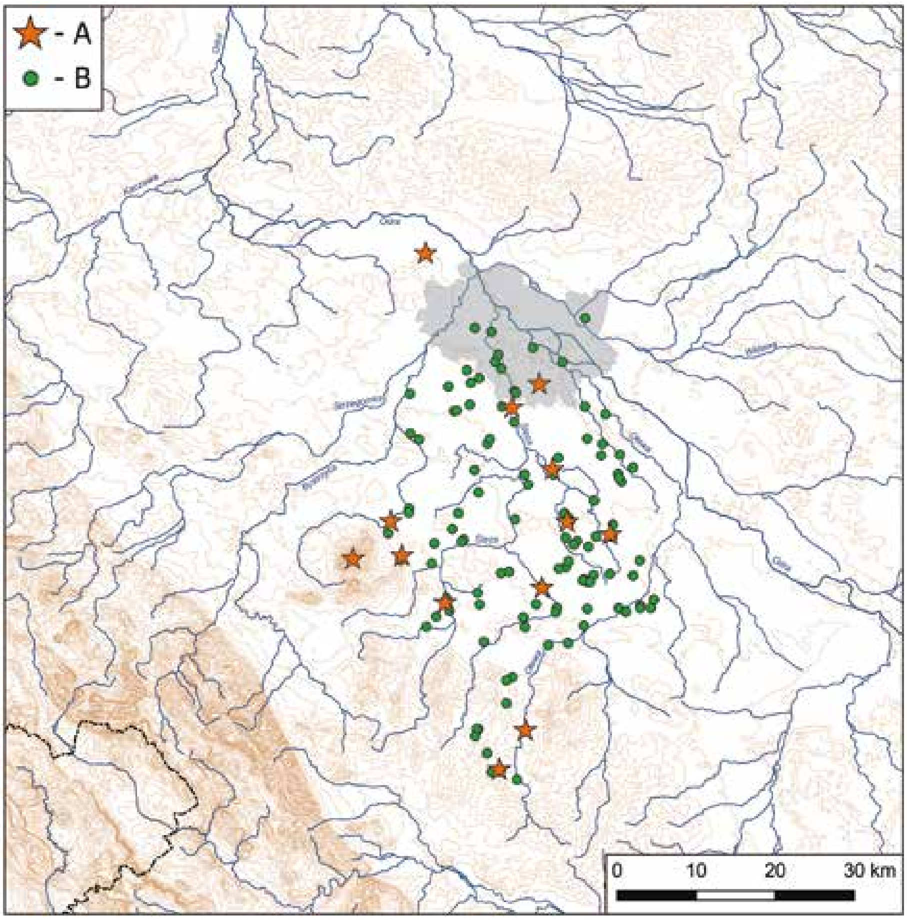

Fig. 29. La Tène Culture in Lower Silesia. A – sites dated to Stage LT C1; B – other sites (compiled by P. Dulęba).

This category of tableware vessels is frequently difficult to distinguish due to the significant weathering of sherd surfaces. Since surface treatment is the primary feature distinguishing them from pots (alongside wall thickness), some vases with damaged surfaces might have been classified as kitchenware vessels.

Our next category – jugs – includes vessels with a handle, maximum body diameter at least 1.3 times greater than the neck diameter, and height greater than the maximum body diameter. Their surfaces were typically polished, less often unpolished or roughened.

Pots and storage vessels constitute the most differentiated and capacious category of pottery finds, comprising non-tableware vessels, that is, medium-sized and large vessels for kitchen and household purposes. They have medium-thick or thick walls, surfaces usually unpolished, roughened or textured, and heights greater than maximum body and rim diameters. Differences between pots and storage vessels are not evident: the largest specimens (over ca. 30 cm in diameter) were most probably used for storing goods, and smaller, frequently featuring handles were also suitable for cooking.

The discussed sites produced pottery assemblages in which the earliest elements might be dated even as early as the final part of Stage LT C1, as indicated by the already mentioned vase/tureen from Wilczków (Fig. 21: 1), which has an exact match in a relatively well-dated Grave 158 from Babi Dół-Borcz. A significant part of the pottery finds presented in this paper display features generally situated within stages A1–A2, at the latest in Stage LT D1 in La Tène Culture terms. The Mötschwil-type fibulae found in Feature 6 in Wrocław-Muchobór Mały and Feature 649 in Wrocław-Muchobór Wielki established the dating of these features to Stage LT C2. Thus, the sites discussed here constitute a chronological horizon that, until recently, was scarcely represented in Lower Silesia. In geographic terms, the pottery assemblages presented in this paper have matches in settlement and grave contexts across the Polish Lowland. The finds from Wilczków, which were also the best preserved, have probably the most surprising parallels. Some vessels do not have exact matches in the Polish Lowland but in Jutland, which clearly shows that the primary vector of cultural connection at that time reached the shores of the North Sea. While Lower Silesia maintained its links with the south in the early La Tène Period, in the course of the middle La Tène Period, it turned to the north.

Settlement context – the Ślęza River micro-region in LT C

Although those relatively few and seemingly unremarkable finds do not make a dramatic impression, they constitute significant evidence in reconstructing the course of cultural changes in Lower Silesia in the Iron Age. Until recently, the subject literature failed to credibly explain and reconstruct the disintegration process of the La Tène Culture settlement and the emergence of the Przeworsk Culture communities in this region.[45] The main difficulty in such studies was the lack of archaeological evidence from the middle La Tène Period.

The state of the art on the final horizon of the La Tène settlement in the Bystrzyca, Ślęza, and Oława river zones has not changed significantly in recent years. The relatively numerous La Tène Culture grave assemblages originate in the early La Tène Period.[46] However, the growing corpus of settlement finds indicates that the La Tène communities inhabited the discussed area in the earlier part of the middle La Tène Period, that is, during stages LT C1a and LT C1b according to R. Gebhard's system (1989). These finds include, first of all, Celtic coins (specimens from coinage period A according to K. Castelin) and fragments of glass bracelets (representing groups 5a, 5b, 6b/1, 8b according to Th. E. Haevernick) dated to LT C1 (Fig. 29). Two of the discussed specimens come from well-documented settlement contexts. They were recorded in the pit-house fills in Górzec, Strzelin district, and Ślęza, Wrocław district.[47] These two pit houses are presently Lower Silesia's latest precisely dated La Tène Culture features. At the same time, the Bystrzyca, Ślęza, and Oława drainage basins yielded a small group of finds strongly associated with the Jastorf Culture.[48] Their circulation in the discussed area in the course of Phase LT C1 or at the turn of LT C1 and C2 – for such a dating might be cautiously suggested – was difficult to explain.

The subject literature has frequently articulated that the area where the La Tène Culture communities had formerly settled lacks Przeworsk Culture assemblages that might be precisely and undoubtedly dated to its earliest horizon, Stage A1.[49] In the La Tène Culture terms, it corresponds with stages LT C1–C2.[50] This clearly contrasts with the vast number of finds originating in Stage A2. Such state of the art mainly resulted from the lack of burial finds on which the Przeworsk Culture chronology rests. This 'cognitive dichotomy' is particularly distinct for the Iron Age in Poland and applies also to the early Przeworsk Culture. Only settlement excavations conducted at a substantial scale during the past 20 years showed the diversity and intricacy of the cultural changes at the turn of the early and late pre-Roman Iron Age. In the burial custom, these phenomena remained elusive.

Finds from Wrocław-Muchobór Mały and Wrocław-Muchobór Wielki allow – at least partially – for establishing a more precise chronological framework. At both sites, finds from the late pre-Roman Iron Age occurred with bronze Mötschwil-type fibulae imported from the La Tène cultural zone. They are often interpreted as the main chronological marker of Stage LT C2.[51] The greatest number of such finds was recorded in Switzerland, where the eponymous site is situated.[52] Such fibulae have also been found in many other places in the La Tène world: in Rhineland, Bavaria, Württemberg, Austria, Bohemia, Moravia, Carpathian Basin, north Balkans,[53] as well as in Silesia. Manufacturing of the Mötschwil-type fibulae took place at the inter-regional craft and trade centres in Nowa Cerekwia[54] and in Němčice nad Hanou in Moravia[55]. Both sites yielded a substantial series of finished and unfinished specimens. Mötschwil-type fibulae also occur in the earliest occupation stages at the oppida.[56]

A fully preserved specimen of the discussed fibula comes from the immediate vicinity of the discussed micro-region. The settlement in Brodno, Środa Śląska district,[57] is situated by the Oder river valley and – apart from the abundant Przeworsk Culture finds – produced Jastorf-type evidence.

The Mötschwil-type fibulae were the only La Tène Culture artefacts found at the sites discussed above. All of these locations failed to produce any La Tène Culture potsherds, which could indicate the existence of La Tène Culture settlement in the area. Thus, there is so far no evidence for the co-existence of the local Celtic population with the newcomers from the north. This clearly

[45] Dulęba 2019b, 152–153.

[46] Dulęba 2014, 197, n. 8.

[47] Gralak 2012, 142, fig. 6a; Dulęba 2019a, 122–123, fig. 37:1.

[48] Grygiel 2018, fig. 168; Dulęba, Markiewicz 2021, 384, fig. 21; Markiewicz 2024.

[49] Dąbrowska 1988, 108–110; Dulęba *et al.* 2018, 362–363.

[50] Grygiel 2018, 352–375, fig. 174.

[51] Polenz 1971, 43–44; Polenz 1982, 109; Stöckli 1974, 369, fig. 1.

[52] Stähli 1977, 83–87, fig. 19.

[53] Márton 2004.

[54] Observation of unpublished finds from Nowa Cerekwia (Museum of Opole Silesia).

[55] Márton 2004, 281; Čižmář *et al.* 2018, 19–20.

[56] Čižmář *et al.* 2018, 38–39.

[57] Bykowski 1977, 47.

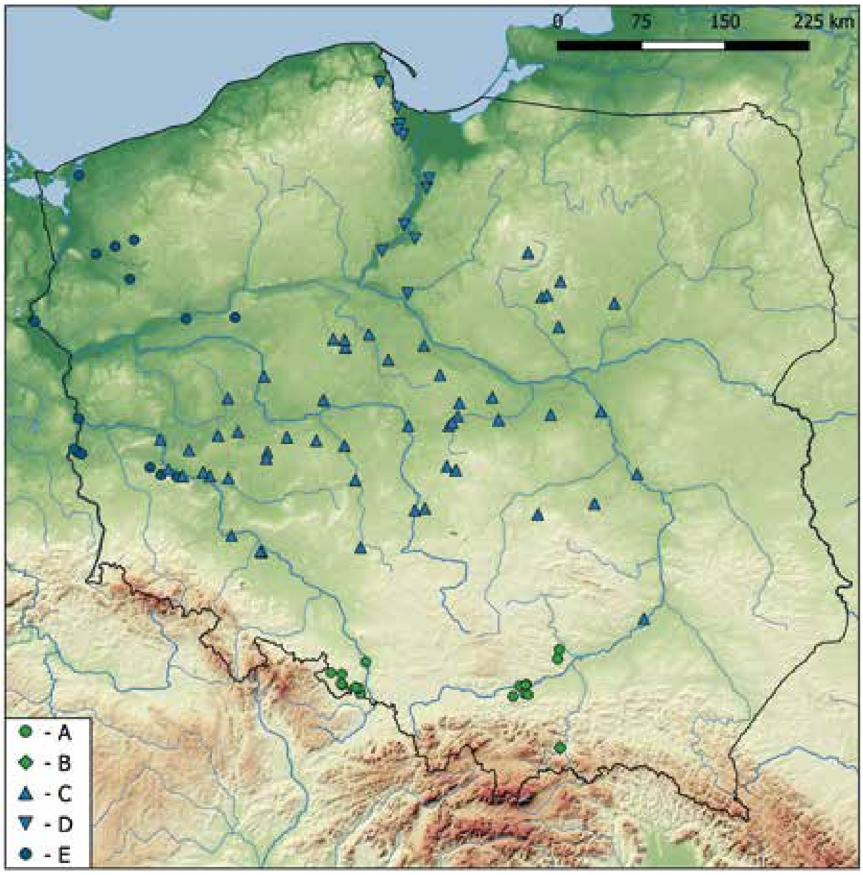

Fig. 30. Sites precisely dated to Stage LT C2 in present-day Poland. A – La Tène; B – Púchov; C – Przeworsk; D – Oksywie; E – Jastorf (compiled by P. Dulęba).

contrasts with the situation in Upper Silesia, where the La Tène Culture settlements almost always produce at least a few 'Germanic' potsherds.[58]

The recently published pre-war finds from Site 1 in Wrocław-Partynice[59] show that ceramic vessels fashioned in Jastorf style are found with those matching the typical, so-called 'early style' Przeworsk Culture assemblages, generally dated to stages A1 and A2.[60] Moreover, in many cases, classifying the particular finds to existing cultural units turns out to be complicated or, in the best case, arbitrary. We argue that the same conclusion applies to the evidence from the here discussed sites in the Ślęza river valley.

Conclusions

The question yet to be answered is, thus, how can finds and assemblages with stylistic features linking them to both Przeworsk and Jastorf traditions be classified? The same problem is valid for the so-called Gubin Group in its later phases, in which the finds bear a significant similarity to the finds from the nearby Przeworsk sites (e.g., sites in the vicinity of Głogów). So far, the source base is too scarce to formulate detailed conclusions. The finds discussed in this paper, as well as our general overview of the archaeological material from Lower Silesia, indicate that the emergence of the Przeworsk Culture in the area was a slow process. Only at the onset of the late La Tène Period (Stage A2) did it come to light in a fully-shaped, independent form. As M. Grygiel has convincingly argued in his monographic description of this phenomenon, the Jastorf population has unquestionably played a key role.[61] At the same time, it is crucial to remember that this phenomenon covered the whole middle La Tène Period. The emergence of the discussed horizon of finds likely marked the end of the existence of the local

[58] Cf. Woźniak 1992, 11–12, fig. 3-4. Observation of unpublished finds from Nowa Cerekwia, Łany, Sułków (Museum of Opole Silesia), and Samborowice (Silesian Museum in Katowice).

[59] Dulęba, Markiewicz 2021.

[60] Dąbrowska 1988, 30, fig. 1, pls. 1–3.

[61] Grygiel 2018, 352–375.

La Tène settlement. Its continuance into Stage LT C2 does not seem probable in Lower Silesia. An overview of precisely dated sites from the discussed chronological horizon (Fig. 30) shows the spread of the non-La Tène populations and gradual occupation of the whole Oder and Vistula zone. The existing evidence indicates that stable Celtic settlement in Stage LT C2 existed only in Upper Silesia and western Lesser Poland.

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'Trzciniec' Pottery from Żanęcin, Otwock District, as an Example of Southern Cultural Influence in the Masovian Lowlands

Abstract

The Trzciniec Culture and Eastern Trzciniec Culture, or in more general terms the phenomena jointly known as the Trzciniec-Komarów-Sośnica Cultural Complex or the Trzciniec Cultural Sphere, are culturally heterogeneous Bronze Age communities dated to between ca. 1900 BC and ca. 1000 BC, inhabiting large swathes of Central-Eastern Europe. The only cultural marker enabling relatively reliable identification of the said communities is their characteristic pottery. For it is in the ceramic vessels where the echoes of cultural heritage of the societies that co-created this phenomenon have been preserved, along with various influences of social groups neighbouring them spatially and temporally. However, their identification and interpretation is far from straightforward, due to the scarcity of other types of artefacts, including bronzeware. One of such problematic questions is related to the reception of Transcarpathian cultural influences by south-western groups of the 'Trzciniec' communities (including those from Lesser Poland) and their transmission further northwards, into the Masovian Lowlands. The 'Trzciniec' settlement in Żanęcin, Otwock district, excavated five years ago, provided new and significant data shedding light on the question discussed above. The present text addresses the said research issues.

Keywords: Bronze Age, Trzciniec Culture, pottery, Masovian Lowlands, southern cultural influence, chronology

Introduction

The Trzciniec Culture and Eastern Trzciniec Culture, or in more general terms the phenomena jointly known as the Trzciniec-Komarów-Sośnica Cultural Complex or the Trzciniec Cultural Sphere, are nothing more and nothing less than archaeological concepts. They have their dedicated champions and enemies. However, what lies hidden behind them are nameless and fairly heterogeneous socio-cultural units from the Bronze Age, dated to between ca. 1900 BC to ca. 1000 BC, inhabiting large swathes of Central-Eastern Europe.[1] One may even risk stating that the only thing that they really have in common, at least when it comes to elements preserved to this day and affording relatively reliable cultural identification of the said groups, is their characteristic pottery.[2] It is in the ceramic vessels where the echoes of cultural heritage of the societies that

[1] Makarowicz 2001; 2010.

[2] Czebreszuk 1998.

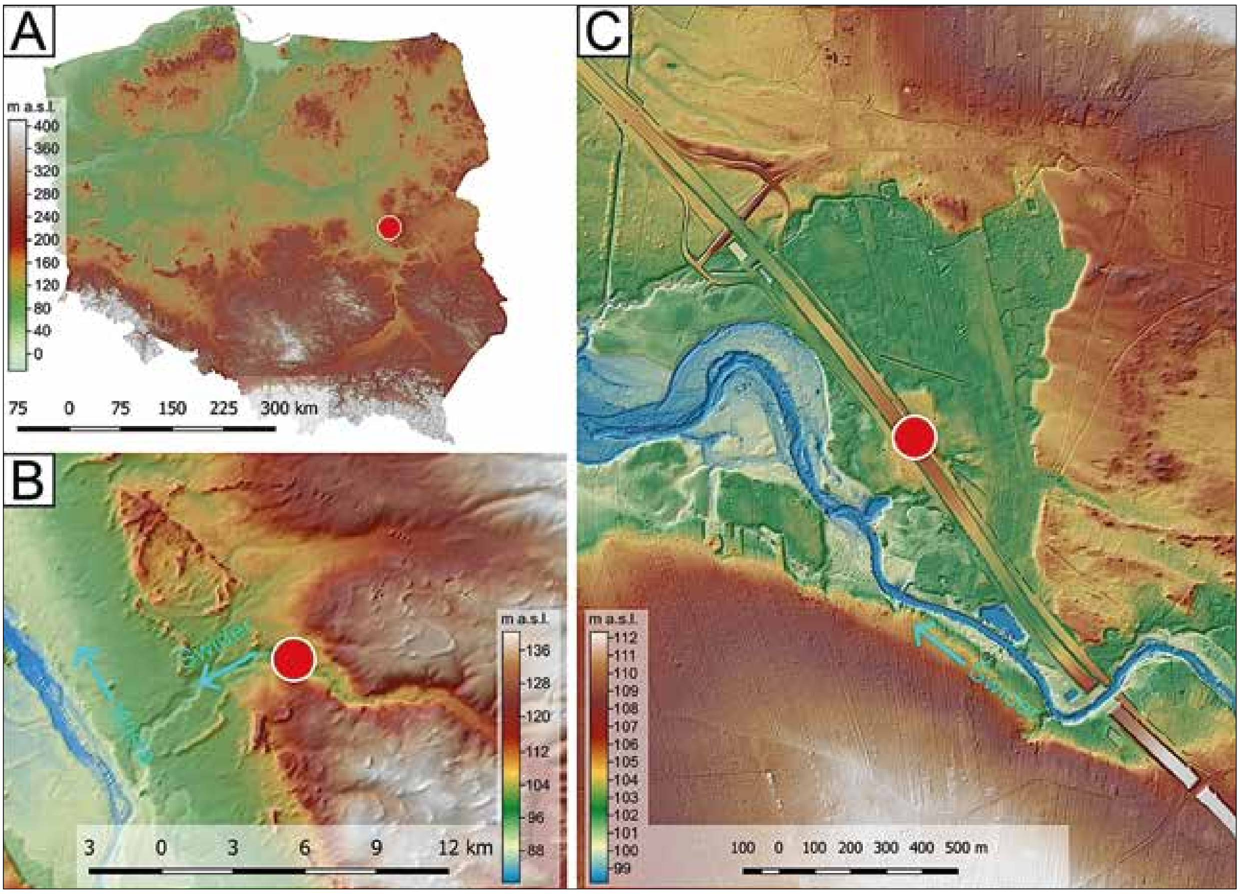


Fig. 1. Żanęcin, Site 9, Otwock district, Masovian voivodship. Site location marked on the schematic model of Poland's landform relief (A), a section of the Vistula valley (B) and a segment of the Świder River valley (C) (compiled by K. Żurek).

co-created this phenomenon have been preserved, along with various influences of social groups neighbouring them spatially and temporally.[3] However, their identification and interpretation is far from straightforward, due to the relative scarcity of other types of artefacts, including bronzeware, which could support present inferences about various cultural relations and processes.[4] One of such problematic questions is related to the reception of Transcarpathian cultural influences by south-western groups of the 'Trzciniec' communities (including those from Lesser Poland) and their transmission further northwards, into the Masovian Lowlands. The issue has already been noted by Jacek Górski, who considered the Vistula River as the main communication route.[5] Whereas the Transcarpathian influences are clear along the left tributary of the said river, reaching their limits in Kuyavia, similar traces have so far been scarce to the east of it. Moreover, they have been limited almost exclusively to potsherds from single vessels, all of which were decorated in a similar manner, characteristic for the Lesser Poland groups. This picture seems to be shifting as the excavations progress, mostly thanks to rescue works or investigations related to infrastructural investments. One such place, rich in new and significant data relevant for the present discussion, is Żanęcin, Otwock district (Fig. 1: A), where traces of habitation by members of the Trzciniec community are accompanied by a relatively large assemblage of pottery with southern inspirations. The present contribution aims to introduce the aforementioned ceramic artefacts and place them in the cultural context of the 'eastern branch' of the emerging meridian communication route.

[3] Makarowicz 2010; Wawrusiewicz *et al.* 2015, 195; Manasterski 2016, 131–137; Wawrusiewicz *et al.* 2017, 173.

[4] Makarowicz 2010, 333–359.

[5] Górski 2011.

Materials and methods

Site 9 in Żanęcin, designated in the documentation of the National Institute of Cultural Heritage as AZP 58-69/78, is located in the Masovian voivodship, in Otwock district (Fig. 1: A, B). According to the adopted divisions of physico-geographical regionalisation, this area belongs to the Garwolin Plain – a mesoregion of denudation plains composed of sandy-clay deposits, forming part of the Central Masovian Lowland.[6] The dominant soil types here are brown soils developed on loamy sands and glacial tills. In the eastern part, on the higher terraces of the Vistula, rusty soils occur, while the river valleys are dominated by alluvial and groundwater gley soils.

The site is situated on the elevation of a Pleistocene alluvial fan, dissected by the waters of the Świder River – a right-bank tributary of the Vistula. It is now an exposed area forming a fragmentarily preserved older terrace within the valley, near the right bank of the river's present-day channel (Fig. 1: C).

The archaeological excavations were commissioned by the General Directorate for National Roads and Motorways and carried out in 2019 by a consortium of companies: Zabytki, Badania, Projekty, Realizacje Michał Grabowski and Pracownia Archeologiczna Mirosław Mazurek. The research covered an area of nearly 7,000 m^2 and was related to the construction of the S17 expressway.[7] The area designated for archaeological investigation was cleared of trees and shrubs and then covered with a survey grid aligned with the geographical coordinate system, where the ordinate axis was assigned lettered labels and the abscissa axis numerical labels. The modern humus layer, approximately 30 cm thick, was removed using machinery. The exploration of cultural layers and subsurface features (various types of pits and structural remains) was conducted manually. All finds were recorded three-dimensionally and documented both photographically and through drawings. Small pits were excavated in their entirety, while larger ones were divided into halves or quarters, with profiles of their fills also documented. The research confirmed human activity in this area during the Mesolithic, the Bronze Age, the Roman Period and the modern era – from the late 19th and throughout the 20th century. For the latter period, particularly distinct traces of combat from World War II were identified, significantly disrupting earlier stratigraphic sequences. However, the precise three-dimensional recording of individual artefacts enabled further analysis[8], especially detailed studies of Trzciniec Culture pottery, along with a spatial-contextual analysis of their distribution.[9]

Prehistoric artefacts, including the Bronze Age potsherds of interest, were recorded exclusively in the subsurface strata – within a stratigraphically indistinct and completely eroded cultural layer. No subsurface features can be associated with this phase, as nearly all features identified at the site relate to the modern use.

The recovered materials underwent a preliminary cultural and chronological classification aimed at identifying key assemblages reflecting different phases of site use. This was achieved through a macroscopic comparison of raw material, technological and stylistic attributes. Of the 1,407 identified fragments of prehistoric pottery, as many as 1,381 (over 98%) were classified within the Trzciniec Cultural Circle and subjected to further detailed analysis. The remaining 26 fragments belonged to three vessels of the Lusatian Culture, which is associated with a completely different context.

The entire pottery assemblage relevant to this study was characterised using formalised analytical systems developed by researchers of the Kuyavia region, as well as the Lesser Poland patterns applied to the analysis of lowland assemblages of the Trzciniec Cultural Circle. Technological features were described according to the framework established by Janusz Czebreszuk,[10] with later modifications and refinements by Przemysław Makarowicz.[11] Rim edges were classified based on the typology of Aleksander Kośko[12], while bases were characterised following the classification proposed by J. Czebreszuk.[13] The description of decorative patterns and macromorphological features was based on the approach outlined by Jacek Górski.[14] All data concerning the identification of formal characteristics of Trzciniec pottery are presented in tabular form (Tab. 1), while selected distinctive vessel fragments are illustrated graphically (Figs. 2, 3).

To determine the absolute chronology of Trzciniec settlement in Żanęcin, radiocarbon analyses were conducted in 2020 at the 14C and Mass Spectrometry Laboratory of the Institute of Physics, Silesian University of Technology in Gliwice. For the study, fragments of stylistically characteristic (ornamented) vessels were selected, on whose inner surfaces traces of organic substances – carbonised residues – were preserved (Fig. 4: A). This resulted in two BP dates: 2875±35 (GdA-6091)

[6] Solon *et al.* 2018; Szumacher *et al.* 2021, 297.
[7] Mazurek *et al.* 2020.
[8] Mazurek *et al.* 2020.
[9] Manasterski, Wawrusiewicz 2020.
[10] Czebreszuk 1996, 12–29.
[11] Makarowicz 1998, 78–87.
[12] Kośko 1981, 32–33.
[13] Czebreszuk 1996, 38–39.
[14] Górski 2007; Górski *et al.* 2011a.

Table 1. Specification of Trzciniec Culture pottery from Site 9 in Żanęcin, Otwock district, Masovian voivodship.

Element no.	Fig. no.	Sec.	Inv. No.	Fragment ID	Technological type/group/cycle	Macromorphological type	Edge type	Bottom type	Decorative motif	Comments
1	3:1	A 7	82	k	6/J/IIb		2j		XIII	
2	3:3	A 7	82	b	6/J/IIb				XXa	
3		A 7	82	b	6/J/IIb				XXa	
4	3:2	A 7	82	b	6/J/IIb				XXb	
5		A 7	82	bd	6/J/IIb			?		
6		A 8	91	b	22/E/IIa				XXVII	
7		A 9	98	b	5/J/IIb				XVa	
8		B 6	83/37	k	22/E/IIa		17j			
9		B 7	88	k	15/E/IIa		19j			
10		B 7	88	szb	22/E/IIa				Id	
11		B 7	88	k	16/K/IIb		18j			
12		C 6	321	szb	22/E/IIa		18j		XVd	
13		C 7		k	15/E/IIa					
14		D 7	336	sz	22/E/IIa				XVa	
15		D 7	336	k	22/E/IIa		17h		XVa	
16		D 7	336	k	22/E/IIa		17e			
17		D 7	336	k	22/E/IIa		20j			
18		D 7	336	k	29/E/IIa		19e			
19		D 7	336	k	22/E/IIa		17h		XVa	
20		D 7	336	k	29/E/IIa		17h			
21		D 8	333	b	5/J/IIb				?	
22		E 7	375	k	7/L/IIc		17j			
23		E 7	375	k	18/L/IIc		17c			
24		E 7	375	b	18/L/IIc				*	*presumably fragment of XVń
25		E 8	374	k	24/J/IIb		17e			
26		E 10	361	k	22/E/IIa		17j		XVa	
27		E 10	361	k	22/E/IIa		17j			
28		E 10	361	d	19/L/IIc			15a		
29		E 11	347	k	22/E/IIa	G.2	9d		Ia	
30		E 11	347	sz	29/E/IIa				Ia	
31		E 11	347	sz	22/E/IIa				Ia	
32		E 11	347	b					?	
33	3:7	E 11	347	k	22/E/IIa	M.2.2.b	4h		XXIV	

Table 1. Cont.

Element no.	Fig. no.	Sec.	Inv. No.	Fragment ID	Technological type/group/cycle	Macromorphological type	Edge type	Bottom type	Decorative motif	Comments
34		E 11	347	k	22/E/IIa		17e		XVa	
35		E 11	347	k	29/E/IIa		20j			
36		E 11	347	szb	22/E/IIa				XVy	
37		E 11	347	k	22/E/IIa		17j			
38		E 11	347	k	19/L/IIc		17j			
39		E 12	358	k	29/E/IIa		1j		XVa	
40		E 12	358	k	19/L/IIc		19d		XVa	
41	2:3	F 8	373	szb	7/L/IIc				XVy	
42		F 8	373	szb	7/L/IIc				XVy	
43		F 8	373	k	19/L/IIc		19j			
44	2:2	F 8	373	k	22/E/IIa		19j		XVa	
45		F 8	373	k	22/E/IIa		17j		XVa	
46		F 8	373	k	22/E/IIa		17j			
47		F 9	373	sz	22/E/IIa				XVa	
48		F 9	344	k	22/E/IIa		1k			
49		F 9	373	k	19/L/IIc		18j			
50		F 10	329	k	19/L/IIc		17j		XVa	
51		F 10	346	szb	19/L/IIc				Ia	
52		F 10		k			26c			
53		F 10	329	szb	15/E/IIa				Ia	
54		F 10		k	22/E/IIa		17j?		XVa	
55		F 10	329	k	22/E/IIa		17j		XVt	
56		F 10	329	szb	19/L/IIc				XVy	
57		F 10	346	k	22/E/IIa		1j			
58		F 10	346	szb	29/E/IIa				Ia	
59		F 10	346	k	22/E/IIa		17j		XVa	
60		F 10	346	b	22/E/IIa				XVy	
61		F 10	346	szb	22/E/IIa				XVy	
62		F 10	329	k	16/K/IIb		19j		XVa	
63		F 10	346	k	29/E/IIa		2e			
64		F 10	346	szb	22/E/IIa				XVa	
65		F 10	346	szb					XVa	
66		F 10	346	sz	22/E/IIa				XVa	
67	2:1	F 11	359	kszb	22/E/IIa	G.1.1.1.	17j		XVy	
68	2:6	F 11	118	k			17k		XVy	

Table 1. Cont.

Element no.	Fig. no.	Sec.	Inv. No.	Fragment ID	Technological type/group/cycle	Macromorphological type	Edge type	Bottom type	Decorative motif	Comments
69		F 11	359	k	22/E/IIa		17j		XVt	
70	3:4	F 11	118	kszb	22/E/IIa	M.2.2.b	17l		XXIV	
71		F 11	328	szb	19/L/IIc				Ia	
72		F 11	118	k	22/E/IIa		19j			
73	3:6	F 11	359	k	22/E/IIa	M.2.2.b	17k		XXIV*	* with elements of XVa
74		F 11	359	k	22/E/IIa		17j			
75		F 11	359	k	22/E/IIa		17j		XVa	
76		F 11	359	k	29/E/IIa		17j		XVd	
77		F 11	118	k			18j		XVa	
78		F 11	359	k	22/E/IIa		2k			
79	2:4	F 11	359	kszb	19/L/IIc	G.1.1.1.	1e		XVy*	only wavy line with dots
80	2:7	F 11	359	ksz	15/E/IIa	G.1.1.1.	2c		Ia	
81	3:5	F 12	372	ksz	22/E/IIa	M.2.2.b	17j		XXIV	
82		F 12	233	b	22/E/IIa				XXIIj	
83		F 12	359	k	29/E/IIa		1j		XVa	
84		F 12	359	sz	8/L/IIc				XVy	
85		F 12	372	b	22/E/IIa				XXVII	
86		G 9	369	b	22/E/IIa				XVy?	
87		G 9	369/348	kszb	22/E/IIa	G.1.1.1.	20j		XVa	
88		G 9	348	k	22/E/IIa		1e			
89	4:A	G 9	369	szb	19/L/IIc				XVt	
90		G 9	370	k	16/K/IIb		1e			
91		G 9		k	18/L/IIc		17j			
92		G 10	370	k	7/L/IIc		17j		XVa	
93		G 10	348	k	22/E/IIa		1k			
94				k	19/L/IIc		1e			
95		G 11	119	?	19/L/IIc					
96		G 12	119	sz	18/L/IIc				XVt	
97		ZY 6	320	d	8/L/IIc			9b?	XVt	
98		ZY 5	334	sz	18/L/IIc				XVt	
99		ZY 8	327	sz	22/E/IIa				XVń	
100		ZY 8	327	k	22/E/IIa		19j			

Table 1. Cont.

Element no.	Fig. no.	Sec.	Inv. No.	Fragment ID	Technological type/group/cycle	Macromorphological type	Edge type	Bottom type	Decorative motif	Comments
101		ZZ 6	319	szb					XXVII	
102		ZZ 7	317	szb	8/L/IIc				Xvy	
103		ZZ 7	317	k	7/L/IIc		17j			
104		ZZ 7	317	b	7/L/IIc				XXVII	
105		ZZ 8	324	k	16/K/IIb		1e		XXIV	
106		ZZ 8	324	k	16/K/IIb		1e			
107		ZZ 8	324	b	22/E/IIa				XVv	
108	2:8	ZZ 8	324	b	6/J/IIb	fragment of a sieve-like vessel				
109		ZZ 8	324	b	6/J/IIb				XVa	
110		ZZ 8	324	k	6/J/IIb		50e			
111		ZZ 8		k			19j			
112		ZZ 8		szb					Ia	
113		ZZ 8	324	k	6/J/IIb		1e			
114		ZZ 8	324	?	6/J/IIb				XXIV	
115		Hałda	441	k	22/E/IIa		1j		Xva	
116		Hałda	441	k	6/J/IIb		17e?			
117	2:7	Hałda	441	kb	5/J/IIb	fragment of a spoon				
118				k	5/J/IIb		1e			
119		ZY 7		sz	22/E/IIa				XVt	

and 1180±45 (GdA-6092). Calibration using the OxCal 4.3 programme[15] with the IntCal13[16] calibration curve allowed for the determination of two time ranges, which, with a probability of 68.2%, can be placed respectively within 1112–1006 BC (Fig. 4: B) and 773–892 AD (Fig. 4: B, C). The second of the obtained results was clearly distorted and will not be taken into account in the analysis.

Results

The high degree of fragmentation of the ceramic material made it difficult to determine macromorphological attributes. Their identification, with certain reservations, was only possible based on larger stylistically distinctive vessel fragments or individual features of their structure. The data obtained in this way are certainly incomplete, and the frequency of some vessel types may be significantly over- or underrepresented due to the distinctiveness of particular structural elements, such as bowl fragments, which are relatively easy to identify in highly fragmented collections. In the analysed assemblage of 'Trzciniec' pottery, 11 forms were identified, including pots, bowls, a sieve-like vessel and possibly a clay spoon.

Among the pots, four specimens with an S-shaped profile and characteristic 'Trzciniec' ornamentation, as well as macromorphological features of Type G.1.1.1,

[15] Bronk Ramsey 2009.

[16] Reimer *et al.* 2013.

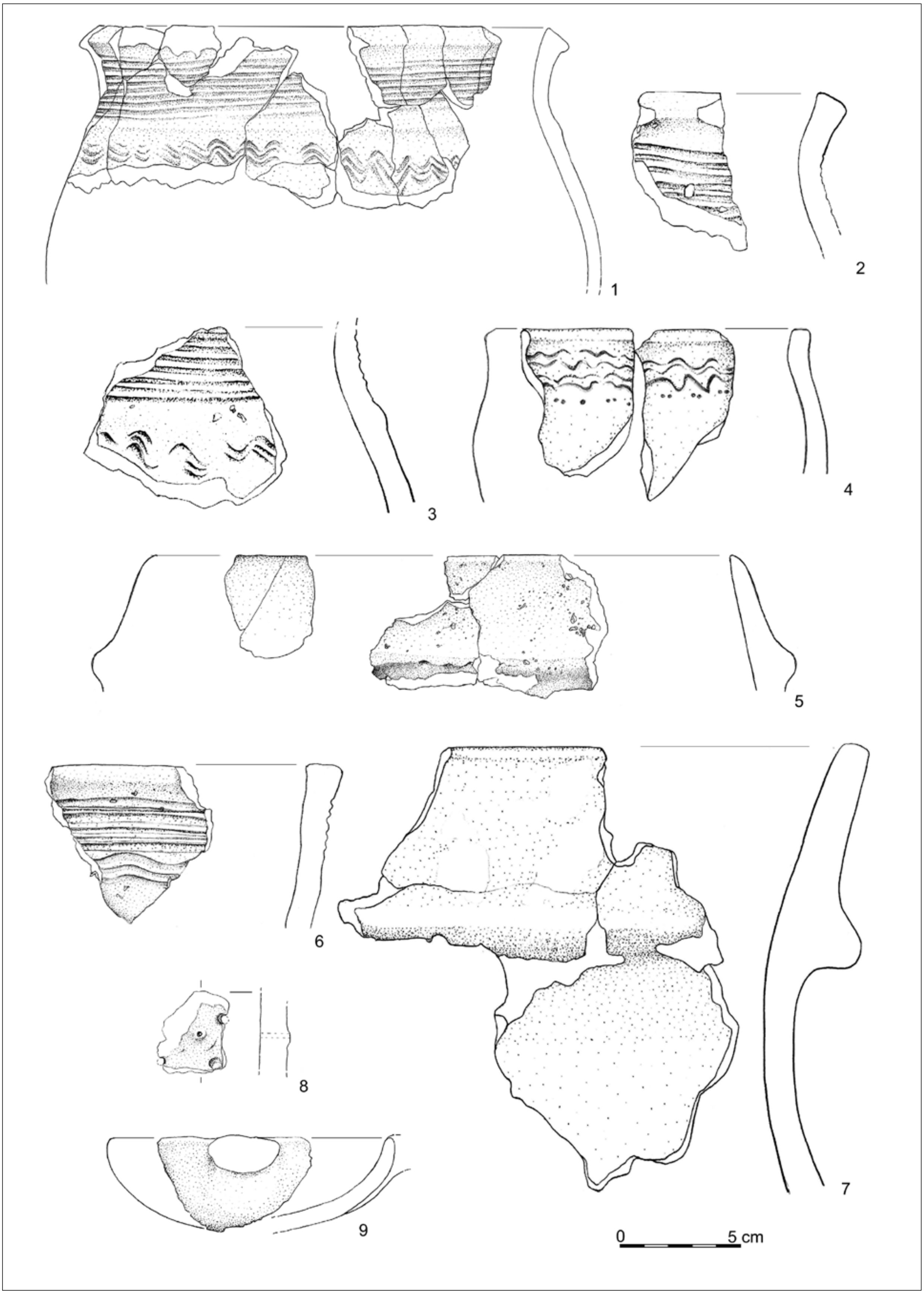


Fig. 2. Żanęcin, Site 9, Otwock district, Masovian voivodship. Selection of 'classic' stylistic elements of 'Trzciniec' pottery (based on Mazurek *et al.* 2020).

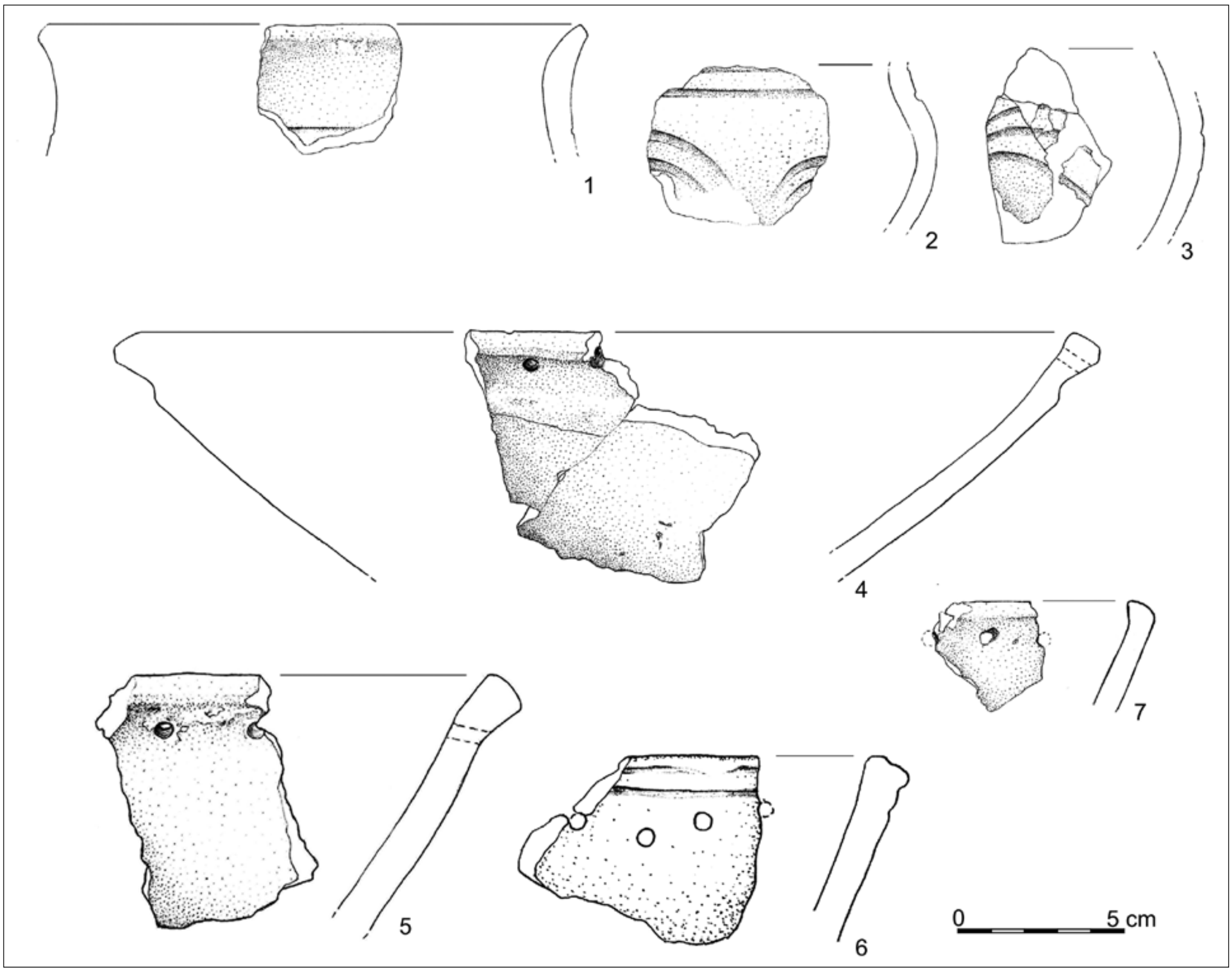


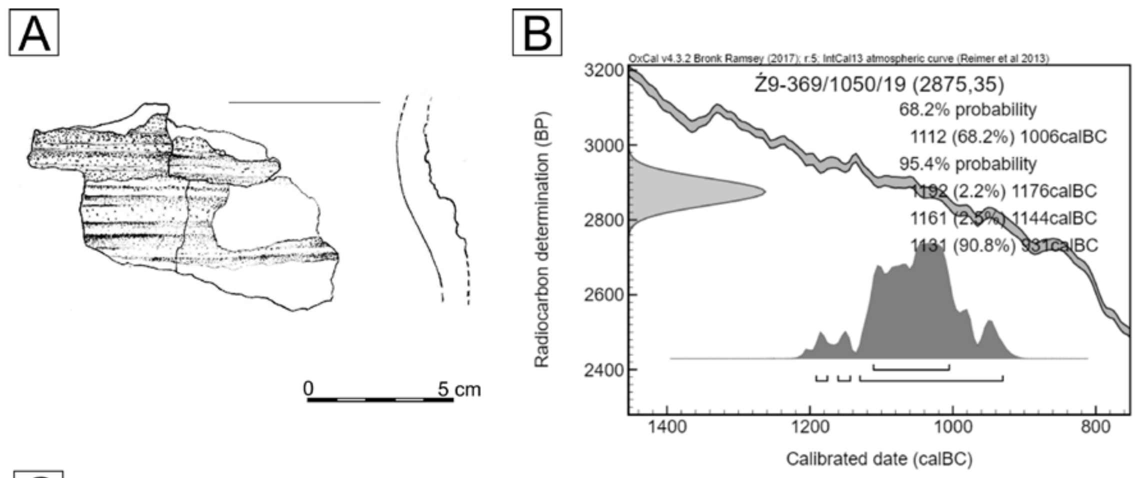
Fig. 3. Żanęcin, Site 9, Otwock district, Masovian voivodship. Selection of 'southern' stylistic elements of 'Trzciniec' pottery (based on Mazurek *et al.* 2020).

were identified (Fig. 2: 1, 4, 7).[17] None were preserved in their entirety, and their identification was based on partially reconstructed upper sections. The S-profiled pots appeared in two main variants differing in decoration: one featuring horizontal grooves on the neck and upper part of the body, accompanied by a plastic band and a wavy line (Fig. 2: 1, 4), and the other displaying only a horizontal plastic band (Fig. 2: 7). The first variant was more common, as suggested by the identification of three specimens and the generally higher frequency of similarly ornamented fragments. Their reconstructed rim diameters range from 15 to 20 cm and are noticeably narrower than the maximum width of the body. The rims are mostly thickened and obliquely cut on the exterior side, though straight rims appeared occasionally. The second variant – S-profiled 'Trzciniec' pots with a characteristic plastic band – was less frequent. This style is represented by a single better-preserved fragment of the upper part of a vessel with a slightly inward-thinned and rounded rim edge. However, determining its exact dimensions proved impossible (Fig. 2: 7).

Among the Trzciniec vessels, barrel-shaped pots (G.2)[18] with a surrounding plastic band also appeared (Fig. 2: 5). One better-preserved specimen had a diameter of approximately 27 cm, with a rim that was distinctly thinned on the exterior side.

Another group of vessels consists of bowls (Fig. 3: 4–7), which are conical specimens (M.2.2).[19] Their characteristic feature is an ornament, of questionable aesthetic value, consisting of a band of perforations beneath

[17] Górski *et al.* 2011a, 38–39.
[18] Górski *et al.* 2011a, 39, 44–45.
[19] Górski *et al.* 2011a, 45; Górski 2023, 52.



C

Nr	Numer laboratoryjny	Nazwa próbki	Data ¹⁴C (BP)	Wiek kalendarzowy BC/AD (kalibrowany)
1	GdA-6091	Ź9-369/1050/19	2875 ± 35	prawdopodobieństwo 68.2% 1112BC (68.2%) 1006BC prawdopodobieństwo 95.4% 1192BC (2.2%) 1176BC 1161BC (2.5%) 1144BC 1130BC (90.8%) 930BC
2	GdA-6092	Ż9-373/1181/19	1180 ± 45	prawdopodobieństwo 68.2% 773AD (68.2%) 892AD prawdopodobieństwo 95.4% 710AD (5.7%) 745AD 764AD (89.7%) 975AD

Fig. 4. Żanęcin, Site 9, Otwock district, Masovian voivodship. Potsherd dated by radiocarbon analysis – lab no. GdA-6091 (A) with calibration (B) and summary of all conducted analyses (C).

the rim, which allows classifying them within Type M.2.2b.[20] The rims of the bowls were shaped in a distinctive manner, with a slight thickening on the exterior side and a straight or diagonally cut edge. The state of preservation of these vessels obscured their exact original dimensions. The only better-preserved specimen has a reconstructed diameter slightly exceeding 30 cm (Fig. 3: 4).

The analysed ceramic assemblage also included a less distinctive fragment of a sieve-like vessel (Fig. 2: 8) and, most likely, a fragment of a large clay spoon with a broken handle (Fig. 2: 9).

Observations of micromorphological features were essentially limited to identifying the shaping methods of the rim edges. Thickened rims on the exterior side predominated (71.43%), with varying degrees of outward inclination and an 'obliquely cut' finish (Fig. 2: 1, 2). A small but noticeable percentage (20%) consisted of straight rims with a predominantly curved, open finish (Fig. 2: 4, 7). Less frequent were specimens with rims that were restricted on both sides – horizontally cut or trimmed externally. Thinned rims appeared rarely, 7.14% (Fig. 2: 5), and forms with an overhanging lip were of marginal significance, represented by only one specimen (1.43%.) A small number of fragments of flat bottoms were not preserved to a degree that would enable classification.

Considering the technological attributes, the 'Trzciniec' pottery from Żanęcin can be divided into four groups, primarily defined by the type and granulation of the additive used. The first and most numerous Group E (accounting for over 62%) consists of fragments of thin- and medium-walled vessels, in which the ceramic mass was tempered with large amounts of coarse crushed

[20] Górski 2023, fig. II.12.

stone. The grains are predominantly white in colour, with sporadically observed selected material in pink or heterogeneous hues. The fracture structure is mostly uniform, occasionally granular, indicating well-prepared ceramic mass. The liberal use and the size of additives result in the characteristic network of cracks on the surface and significant fragility of the walls. The surfaces were smoothed, though often imprecisely, as visible irregularities suggest that this was likely due to the large grain size of the additive. The light brown and/or reddish colour of the pottery suggests firing in an oxidizing atmosphere, but visible stains and discoloration indicate an unstable firing process, meaning it likely took place in an open hearth rather than a pottery kiln. Slightly over 24% of the pottery studied was assigned to Group L, where medium-grain crushed stone was used as the additive. The fractures are usually layered and 'lamellar', which is the result of less meticulous preparation of the ceramic mass. The surfaces are generally even and smooth, although they may also be wrinkled. The occasionally identified 'roughness' is probably the result of post-depositional processes. About 15% of the 'Trzciniec' pottery from Żanęcin was made in the technological convention corresponding to Group J, which encompasses the broadest range of technological experiences of the societies of Late Neolithic and Early Bronze Age from Central Poland.[21] The main additive used was fine-grained crushed stone, sometimes with an identifiable amount of sand. This technique was used for both thin-walled and medium-thickness containers. The additive was typically added in large quantities. The fractures were either uniform or 'leaf-like', indicating relatively good preparation of the ceramic material. The surfaces were most often even, smooth, and showed visible traces of polishing tools. Less than 5% of the total fragments of vessels were classified into Group K. This is a specific variant of pottery that can be described as 'delicate'. It includes containers with wall thicknesses up to 6 mm, made from a ceramic mass with an additive of fine-grained crushed stone and sand.[22] The fractures were typically uniform, occasionally layered, and the surface of the walls was usually smooth, although sometimes slightly wrinkled.

The decorative motifs were identified on 51 specimens (Tab. 1) and divided into seven ornamentation groups. The largest share, reaching 64.86%, consists of horizontal grooves located on the necks and/or upper parts of the bell-shaped vessels, most likely pots (Fig. 2: 1–3, 6). They were often accompanied by a small, circumferential plastic band that horizontally separated the entire composition. At the bottom, the design was closed with a repeated wavy line or, less frequently, a row of short, diagonal grooves. Significantly fewer in number (13.51%), but also notable for their size, are the horizontal strips occurring independently, which were always located on the neck or upper part of the body (Fig. 2: 5, 7). The third in terms of frequency are the small holes (8.11%), which are, however, difficult to classify solely as decorative elements (Fig. 3: 4–6). Other motifs were recorded less frequently or as traces, such as stamps (5.41%), arches (4.05%) (Fig. 3: 2, 3) and pits.

Discussion

Technological, stylistic and morphological attributes of the Trzciniec Culture pottery from Żanęcin allow for the identification of three main components, the co-occurrence of which should be considered on the basis of their spatial dispersion and mutual chronological and topogenetic relationships. Undoubtedly, the most recognisable element is the presence of vessels characteristic of the so-called Podlachian-Masovian Group of the Trzciniec Culture.[23] This group consists of S-profiled pots, typically featuring a thickened and diagonally cut lip, decorated with a motif of horizontal grooves and/or plastic bands running along the neck or upper part of the vessel's body. These decorative elements are some of the distinctive characteristics of typical 'Trzciniec' pottery (Fig. 2).[24] In combination with the characteristic wavy line motif, this creates a distinct 'stylistic atmosphere' of the classical stages of development of the central Masovian groups,[25] which is also clearly present in Eastern Masovia and Podlachia.[26] The overall interaction of these attributes, along with the dominant technology of vessel production based on coarse-grained crushed stone (Technological Group E), corresponds to the post-Linin Stylistic Group 2a, distinguished based on the well-dated and extensive pottery assemblage from Site 1 in Polesie, Łowicz district.[27] Based on the typological, spatial and chronological data estimation conducted there, the period of functioning of the artefacts was determined to fall between the beginning of the 18th and the mid-14th century BC. However, other studies have suggested that similar forms may have persisted into the late developmental stages of the 'Trzciniec' groups.[28] One of

[21] Czebreszuk 1996, 24.

[22] Czebreszuk 1996, 24–25.

[23] *Cf.* Gardawski 1959.

[24] Górski *et al.* 2011a, 66–75.

[25] Taras 1995, map 6.

[26] Wawrusiewicz, Bienia 2014, fig. 7.

[27] Górski *et al.* 2011b, 97, 101, fig. 9.

[28] Taras 1995, 74.

the potsherds from Żanęcin, for which radiocarbon dating returned a range of 1112–1006 BC with a probability of 68.2% (Fig. 4), should also be placed in this stylistic context. This period is more than two centuries later than the typochronological schemes developed based on the findings from Site 1 in Polesie, located in the basin of the Bzura River – a western tributary of the Vistula.

The second group, rather specific and scarcely represented, consists of fragments most likely from a single vessel (a pot or a large jar) decorated with concentric arcuate grooves beneath horizontal grooves located at the transition between the neck and the body (Fig. 3: 1–3). These may have included knobs, but the state of preservation of the fragments does not allow for a conclusive verdict. In contrast to the 'classical' Trzciniec vessels, the shaping of the rim and the vessel's manufacturing technology, based on a mixture of fine-grained crushed stone and sand, also differed. This, along with the other parameters, allowed for its classification within Technological Group J.

Vessels decorated with knobs encircled from above are rare in Central Masovia, having been known from only a few sites, including Linin,[29] where they are considered a result of southern, namely Transcarpathian, inspirations.[30] Similar patterns have also recently been recorded in the Trzciniec inventory from the site in Brwinów, Pruszków district.[31] Relatively small assemblages have also been documented in the Bzura River basin, at the site in Polesie.[32] Examples decorated in a similar way were found there, among others, in the context of Grave Ł150, radiocarbon dated to the range 1495–1425 BC,[33] and Feature B327, dated to 1370–1130 BC.[34] Vessels similar to the one from Żanęcin have also been recorded in the context of a Trzciniec-Mogiła settlement from Szczepidło, located in the Konin district, near the middle Warta River.[35] Based on a series of radiocarbon datings obtained there, the absolute chronology of pottery decorated with concentric arches was determined, placing it within the period of 1269–1236 BC with high confidence (68.2%).

The final, third component of the pottery from Żanęcin consists of bowls – conical vessels, all of which are decorated with a band of perforations below the rim (Fig. 3: 4–6). This form is unusual within the 'Masovian' pottery of the Trzciniec Culture, known only from a few sites located near the villages of Makowiec Duży[36] and Dębowce-Zdrojki (now Dębowce),[37] both in the Mińsk Mazowiecki district. The mentioned specimens, although very similar, have a distinctly semicircular profile, which sets them apart from the examples from Żanęcin. Interestingly, the only area where such forms appear more frequently is Lesser Poland, particularly within the complex of Trzciniec Culture sites located around Nowa Huta. A substantial series of these vessels was discovered at Site 55 – *Kopiec Wandy* [Wanda Mound].[38] These bowls appear in the context of late Trzciniec Culture features. Their fragments were found, among others, in the fill of Feature 228, dated with high confidence (68.2%) to 1302–1204 BC, as well as in Pit B140, which was dated accordingly to the range of 1260–1214 BC.[39]

As follows from the above considerations, the Trzciniec Culture pottery assemblage from Żanęcin, although scarce and poorly preserved, may serve as evidence of significant cultural processes. However, a correct interpretation of its various topogenetic elements requires an assessment of their relative homogeneity. This can be supported by spatial analyses based on the compiled planigraphic documentation (Fig. 5). A general observation of the spatial distribution of potsherds reveals two rather indistinct concentrations – one in the south and one in the north – separated by approx. 30–50 meters.

The first concentration covers an area of approximately 0,11 ha, where the vast majority of finds are clustered. This is also where the highest number of distinctive potsherds have been documented. In one location, all the 'classic' elements characteristic of the Podlachian-Masovian groups coexist, including horizontal grooves, incised wavy lines (Fig. 5: A) and plastic bands (Fig. 5: B). However, they are accompanied by the 'Lesser Poland' conical bowls (Fig. 5: C), which clearly coexisted with the classic elements.

The second concentration, located in the northern part of the investigated area, is significantly less distinct. It covers approx. 0,1 ha, with a noticeably smaller number of potsherds recorded. Similar to the southern concentration, classic elements are clearly present (Fig. 5: A, B), but the 'Lesser Poland' bowls are absent. Nonetheless, one of the sherds found there came from a vessel decorated with concentric arches (Fig. 5: D), whose stylistic features also indicate a southern provenance.

No significant technological differences could be found between the two concentrations. The frequency of individual technological types is similar.

[29] Gardawski 1959, tab. XLIX:2.

[30] Górski 2011, 281.

[31] Skorupska, 2013, tab. 2:4.

[32] Górski *et al.* 2011a, fig. 2.43: 1, 3, 7.

[33] Górski *et al.* 2011a, fig. 3. 29.

[34] Górski *et al.* 2011a, fig. 3. 31.

[35] Makarowicz 2016, fig. 78.

[36] Gardawski 1959, tab. L: 2.

[37] Taras 1995, 63, 67.

[38] Górski 2023, 52.

[39] Górski 2023, 52, tab.III.1.

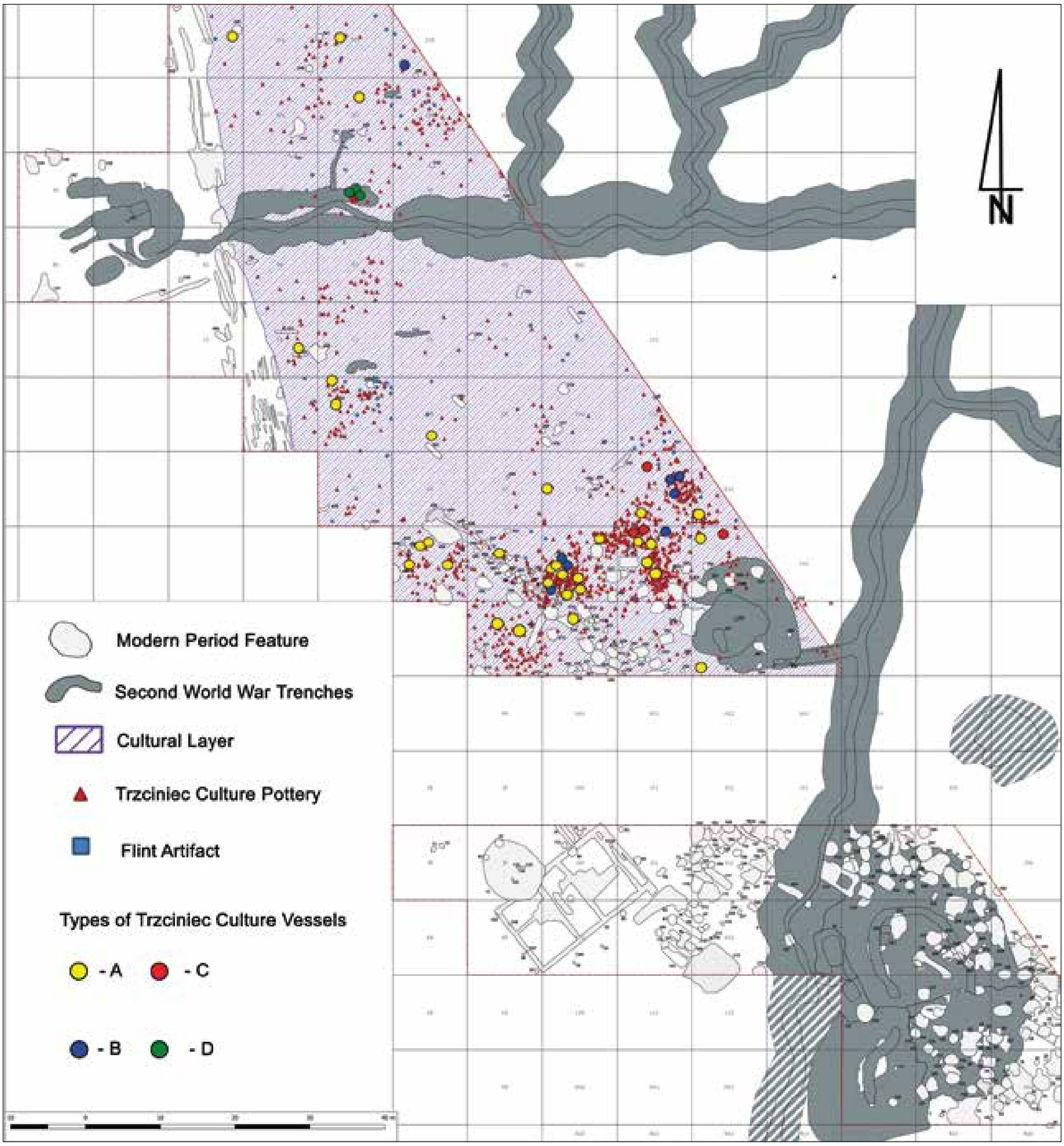


Fig. 5. Żanęcin, Site 9, Otwock district, Masovian voivodship. Spatial distribution of 'Trzciniec' potsherds on the site and the layout of contemporary subsurface features – location of fragments of pots decorated with horizontal grooves and wavy lines (A) or with plastic bands (B), conical bowls (C) and the vessel ornamented with concentric arches (D) (after Mazurek *et al.* 2020, with modifications by the authors).

Based on the presented facts, it can be suggested that both zones of the site functioned simultaneously and represent a small, possibly two-homestead settlement, a significant part of which was 'erased' due to various levelling works in later periods.

In the end, the discussed sources most likely reflect a very late stage in the development of the Central Masovian 'Trzciniec' groups. On the one hand, older stylistic elements, still post-Linin, persist within these groups. On the other, there is a partial, yet visible adaptation of exotic cultural patterns flowing from the south (Fig. 6). In this context, what previously seemed as erroneous radiocarbon dating result of the potsherd from Żanęcin (Fig. 4: A, B) becomes

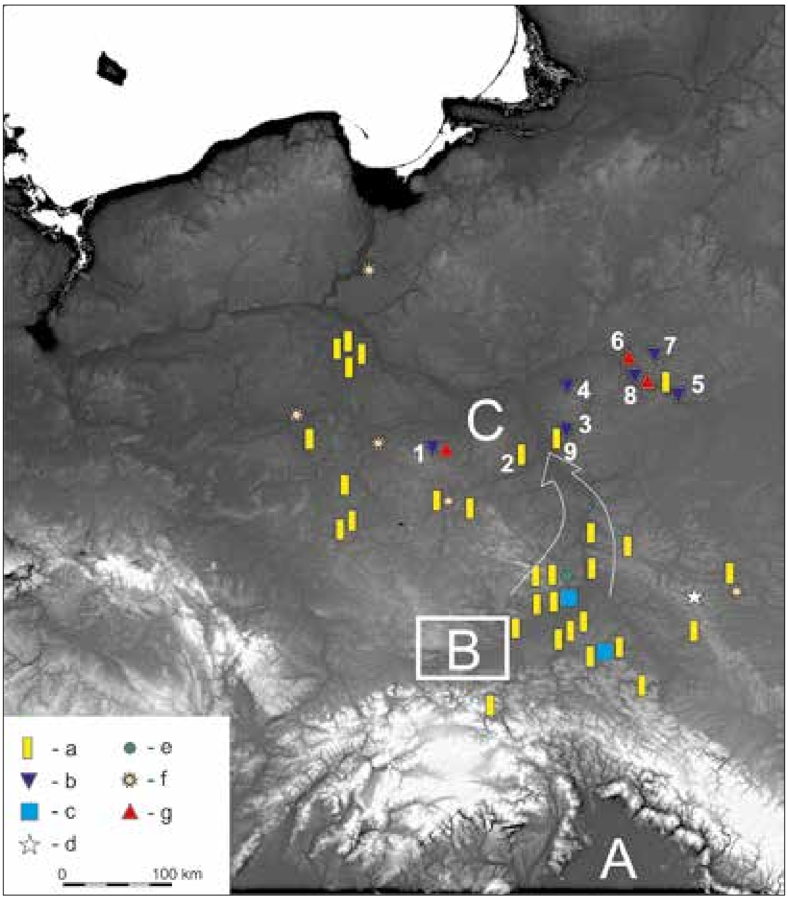


Fig. 6. Location of the Żanęcin pottery finds in relation to selected categories of artefacts with southern features. A – compact range of the Otomani-Fűzesabony Culture; B – Western Lesser Poland; C – remaining area of the Trzciniec Culture. a – vessels with Transcarpathian and Lesser Poland features; b – vessels with Polesie-type stylistic features; c – Krummesser-type knives; d – clay cartwheel models; e – glass beads; f – amber beads; g – tumuli. 1 – Polesie; 2 – Linin; 3 – Zdrojki; 4 – Laski Stare; 5 – Słochy Annopolskie; 6 – Koryciny; 7 – Kiersnowo; 8 – Klepacze; 9 – Żanęcin (based on Górski 2011, fig. 1a, with modifications by the authors).

credible.[40] It is acceptable especially when considered alongside pottery that co-occurs spatially with local imitations of both the 'Nowa Huta' type bowls and burial vessels decorated with concentric arches from Szczepidło near the Warta River. The approximately one-hundred-year delay may result from the peripheral and traditional cultural landscape of Central Masovia, where 'classical' stylistics in pottery production dominated for nearly eight centuries. On the other hand, the presence of 'Lesser Poland', or more precisely 'Nowa Huta' cultural elements, visible for example in the adaptation of bowls as part of a set of vessels, attests to the activity of one of the main communication routes leading southward – the Vistula River.[41]

Conclusions

The settlement's duration must have been rather short, as indicated by the small quantity of movable finds and the lack of spatial features. But then how can we explain the chronological diversity of the documented ceramic sources and the very late radiocarbon date? One solution is to assume that while the tradition of producing 'classic' Trzciniec vessels in this region – the vicinity of Żanęcin or, more broadly, the Świder River basin – was cultivated persistently, at one point the local community absorbed 'southern' novelties. Should this phenomenon perhaps be linked with the presence of an individual from Lesser Poland, who brought with them a slightly different, 'modernised' tradition of pottery making?

[40] Manasterski, Wawrusiewicz 2020.

[41] Górski 2011.

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The Use of Flints in Prehistory and Modern Times on Open Air Sites from Sandy Lowlands. The Case of the Site Żanęcin 9, Wiązowna Commune, Mazowieckie Voivodship

Abstract

Open-air archaeological sites situated on dunes near various rivers are characteristic of the Polish lowlands. Excavations at these sites typically yield chronologically and culturally diverse artefacts made of non-organic materials, such as fired clay or stone. Assigning these artefacts to specific chronological-cultural units is often challenging due to the absence of a clear stratigraphic context. An additional complication arises from the geological characteristics of these dune sites, which lack local stone resources, including flint, that could have been utilised in situ by past human communities. Consequently, flint artefacts discovered at these locations are almost invariably imports, reflecting the activities of different groups across various periods. The patterns of flint exploitation by the communities inhabiting the site discussed in this study were determined through an analysis of analogous material from one of the best-documented sites of this type. At Żanęcin 9, flint was used in two distinct ways. The first involved processing of two varieties of erratic flint on-site, employing diverse methods and techniques, and tool production. This pattern was characteristic of Late Mesolithic and Early Bronze Age communities. The second approach was limited to the transportation of finished artefacts to the site for various purposes, a practice associated with both Early and Late Bronze Age populations as well as modern times societies.

Keywords: Bronze Age, Trzciniec Cultural Sphere, flint artefacts, gunflint, sandy lowlands

Introduction

Open-air sandy sites are typical of many lowland areas in Poland, particularly those located on dunes near various rivers. From an archaeological perspective, they provide information primarily from non-organic sources. Such sites, usually found near rivers that historically served as communication routes, were settled either long-term or episodically by different communities at various times. This is evidenced by accumulations of habitation traces, typically including pottery and flint artefacts. They are usually found outside clear stratigraphic contexts and in various states of preservation, often damaged (e.g., Grądy-Woniecko 1).[1] The total site area also influences the amount and type of information available on settlement processes. However, the size of the site and the extent of its exploration do not necessarily determine the number of archaeological finds or features. An even greater challenge stems from the lack of clear stratigraphy and the extremely poor conditions for organic matter preservation, both of which severely complicate the dating of discovered artefacts. Therefore, the most reliable method for assessing the synchronicity of finds, as well as the intensity and character of settlement in a given period, is the analysis of the horizontal dispersion of specific categories of finds.

An important research aspect is the possibility of indicating the scope of activities carried out on site by various communities over the centuries based on flint raw material, which, however, does not naturally occur in the dunes. The extent of the use of flint by the site's inhabitants can be assessed on the basis of large-scale excavations with precise localisation of artefacts and ecofacts. Accordingly, this paper draws on data and flint finds re-

[1] Wawrusiewicz *et al.* 2017.

trieved during excavations at Site 9 in Żanęcin, Wiązowna commune, Mazowieckie voivodship (Poland). The site is located on the right bank of the Świder River, on a small sandy elevation.[2] The location lies within a sandy and clayey denudation plain known as the Garwolin Plain, which is part of the Środkowomazowiecka Lowland.[3]

Materials and methods

The excavated section of Site 9 yielded 91 flint finds in varying states of preservation (Tab. 1). Six of these are natural forms, while the remaining 85 can be classified as artefacts. The majority originates from a cultural layer, with only four recovered from secondary deposits resulting from modern disturbances of the original stratigraphy (area unit I14 –feature 320, area units: K11 and K15; Fig. 1). Within the cultural layer, the flint finds were scattered without any discernible clusters, typically found near potsherds of various sizes, most of which are attributed to the classical developmental stage of the Trzciniec Cultural Sphere (TCS). In this context, on average, approximately one to five flint artefacts were found in most of the excavated areas. Only three larger clusters were discovered, located 10 to 30 centimetres apart from each other (area units: D7–19 finds; D11–8 finds; and F11–10 finds). Since the spatial dispersion of finds in the excavated area did not reveal any clearly separated spatial units within the cultural layer, the flint items were analysed together.

Their general structure was analysed following the principles of dynamic technological classification.[4] It involves categorizing artefacts according to the sequence of their manufacture, from extracting the raw material to shaping the final products deposited in a given context within the site. The resulting list of tool types includes retouched flake tools, defined based on morphological criteria, mostly related to the placement and form of retouch, observed in Palaeolithic, Mesolithic, Neolithic and modern times artefacts from various parts of the world.[5] Their technological evaluation followed guidelines described in the literature, focusing on force application techniques by tracing marks of direct or indirect percussion and pressure visible on the debitage.[6]

The raw material was identified based on the characteristic features (colour, shine, translucency of the flint mass, type of inclusions in the flint mass, presence and type of cortex) and compared to representative samples from the lithics collection of the Faculty of Archaeology of the University of Warsaw.

Flint raw materials

The flint finds from the cultural layer were made of two types of raw material: erratic and mined (Tab. 2). The erratic flint included two variants dated to the Cretaceous Period. The first was presumably 'local', appearing frequently in the postglacial sands and gravels of Mazovia in the form of small chunks of heterogeneous and differently coloured flint mass. It is represented by 24.1% of the finds. The second resembles the 'north-eastern flint' described by Karol Szymczak.[7] It is macroscopically identical to the Cretaceous flint raw materials, known from the vicinity of Mielnik or flint mines near Krasnasyelski on the Ros River (Belarus) and in the Volhynian Highland. It is represented by 59.3% of the finds. Based on the translucency of the flint mass, both aforementioned variants may be classified as Group I of erratic flint defined by Piotr Dmochowski.[8] Although divisions within the category of Cretaceous flints are debatable[9] and the classification based on translucency does not entirely support the technological evaluation of the artefacts from Site 9, the aforementioned division into variants will still be applied in this study.

Meanwhile, the mined flints are represented by two variants: chocolate, comprising 8.8% of all finds, and Świeciechów flint, present in 1.1% of the assemblage. The primary and secondary deposits of the chocolate flint are located at the north-eastern edges of the Świętokrzyskie Mountains.[10] In contrast, the outcrops of Świeciechów flint are found in Cretaceous layers in the locality of Świeciechów Poduchowny, in the Annopol commune, Lubelskie voivodship.[11]

In general, the erratic flint is represented by 83.4% of the analysed finds and mine flint by 9.9%. The remaining 6.7% are items made of materials impossible to identify due to scorching or overheating.

Both erratic and mine flints on the site can be considered imports from various, more or less distant, places. This is indicated by Site 9 location within the oldest generation of dunes and aeolic formations.[12] Hence, the few pieces of unprocessed flint of two erratic variants (six finds in total) excavated at the site were presumably brought

[2] Mazurek, Sznajdrowska-Pondel 2020, 6.
[3] Kondracki 2009, 196.
[4] For example, Schild *et al.* 1975, 12n.
[5] Ginter, Kozłowski 1990, 79–169; Whittaker 2009, 52–53.
[6] For example, Inizan *et al.* 1992, 60–65; Inizan *et al.* 1999, 73–79; Migal 2005, 136.
[7] Szymczak 1992, 15–29.
[8] Dmochowski 2006.
[9] *Cf.* Sulgostowska 2016.
[10] Budziszewski 2008, 49–87.
[11] For example, Libera, Zakościelna 2002.
[12] *Cf.* Baraniecka 1982, fig. 8.

Table 1. Żanęcin, Site 9, Wiązowna commune, Mazowieckie voivodship. Inventory of flint finds (* = preserved size of the damaged specimen).

No.	Inventory no.	Location		Category of flint finds	Measurements (cm)		
		Area Unit	No. on the plan		Length	Width	Thickness
1.	334	ZY5	402	natural flake	2.8	1.7	0.7
2.	318	ZY7	279	splinter flake, partially cortical	1.1	1.2	0.2
3.	318	ZY7	285	unipolar splintered piece	1.3	1.3	0.4
4.	318	ZY7	281	laurel arrowhead with a tang	2.7	1.1	0.3
5.	327	ZY8	280	flake	1.2	1.0	0.2
6.	327	ZY8	295	bipolar splintered piece with a single orientation change	2.3	2.6	0.7
7.	309	ZZ7	Feature 339/B	natural flake with retouching edge	3.6	1.9	0.5
8.	317	ZZ7	213	blades core with single striking platform	2.7	1.9	2.4
9.	324	ZZ8	188	splinter flake, partially cortical	2.3	1.3	0.6
10.	324	ZZ8	200	splinter flake, partially cortical	3.0	1.2	0.7
11.	324	ZZ8	207	splinter flake – fragment	2.6	1.6*	0.5
12.	324	ZZ8	209	splinter flake	1.7	1.4	0.3
13.	324	ZZ8	212	partially cortical flake	4.0	3.2	0.7
14.	90	A6	45	partially cortical blade (distal fragment)	2.4*	1.5	0.3
15.	90	A6	43	chip	0.7	1.4	0.2
16.	87	A7	1	blade (distal fragment)	2.4*	1.5	0.2
17.	322	C7	227	frost chip	2.8	1.8	0.7
18.	385	C9	1213	natural flake with broken edges	1.8	2.1*	0.5
19.	385	C9	1208	overpassed blade (distal fragment)	2.6*	1.2	0.6
20.	386	C10	1218	blade (middle fragment)	1.0*	1.0	0.1
21.	386	C10	1217	partially cortical blade (distal fragment)	2.0*	1.1	0.2
22.	386	C10	1216	partially cortical flake	1.4	1.2	0.4
23.	387	C11		bipolar splintered piece	1.6	1.5*	0.7
24.	337	D6	492	bipolar splintered piece	1.5*	1.0	0.7
25.	336	D7	459	scraper	2.4	1.4	0.5
26.	336	D7	428	blade (proximal fragment)	1.5*	0.9	0.3
27.	336	D7	467	retouched blade	3.2	1.4	0.3
28.	336	D7	434	truncation	2.1	1.0	0.4
29.	336	D7	449	technological chunk	1.2	1.8	0.7

Table 1. Cont.

No.	Inventory no.	Location		Category of flint finds	Measurements (cm)		
		Area Unit	No. on the plan		Length	Width	Thickness
30.	336	D7	437	technological chunk	1.6	2.3	0.9
31.	336	D7	438	retouched splinter flake	2.9	3.8	0.8
32.	336	D7	442	technological chunk	2.6	1.8	1.0
33.	336	D7	466	retouched flake, partially cortical	1.2	1.3	0.3
34.	336	D7	469	splinter flake, partially cortical	1.5	1.9	0.4
35.	336	D7	440	retouched blade (distal fragment)	1.0*	0.9	0.3
36.	336	D7	473	partially cortical blade (distal fragment)	1.9*	0.9	0.2
37.	336	D7	427	technological chunk	4.3	2.8	1.0
38.	336	D7	426	retouched flake	1.9	1.9	0.5
39.	336	D7	430	technological chunk	2.5	2.2	1.0
40.	336	D7	445	partially cortical flake	1.4	1.2	0.3
41.	336	D7	435	end-scraper – fragment	1.2*	0.9*	0.4
42.	336	D7	432	bipolar splintered piece – fragment	1.8*	1.7*	1.0
43.	336	D7	433	natural flake	4.1	5.0	1.5
44.	333	D8	398	crested blade – fragment	1.3*	0.8	0.5
45.	331	D10	380	blades core with single striking platform	3.1	2.1	3.0
46.	335	D11	405	blade (distal fragment)	1.4*	0.5	0.2
47.	335	D11	415	flake – fragment	2.0	1.2*	0.6
48.	335	D11	407	partially cortical flake	1.4	1.1	0.3
49.	335	D11	413	chip	1.2	0.8	0.2
50.	335	D11	406	partially cortical chip	1.1*	0.8	0.2
51.	335	D11	424	scraper	2.2	1.4	0.6
52.	335	D11	422	end-scraper	1.4	1.6	0.4
53.	335	D11	412	end-scraper with retouching side edge	3.4	1.3	0.3
54.	374	E8	1199	natural flake	2.2	1.8	0.6
55.	374	E8	1206	blades core with single striking platform – fragment	3.0*	2.2	0.9
56.	349	E9	852	flake – fragment	1.9*	1.3*	0.2
57.	347	E11	804	core tablet	2.0	1.9	0.9
58.	347	E11	755	partially cortical flake	2.7	1.8	0.9
59.	347	E11	757	technological chunk	1.2	1.0	0.6
60.	358	E12	992	splinter flake, partially cortical	2.0	1.5	0.3
61.	358	E12	1002	bipolar splintered piece	2.6	1.0	0.7

Table 1. Cont.

No.	Inventory no.	Location		Category of flint finds	Measurements (cm)		
		Area Unit	No. on the plan		Length	Width	Thickness
62.	373	F8	1167	cortical chip	1.1	0.9	0.1
63.	373	F8	1164	partially cortical blade (distal fragment)	2.1	0.9	0.3
64.	373	F8	1128	partially cortical flake – fragment	2.1*	2.5	0.7*
65.	373	F8	1126	crested blade – fragment	2.0*	1.1	0.5
66.	344	F9	498	flake	2.2	2.4	0.6
67.	344	F9	528	bipolar splintered piece with changed orientation	2.9	2.0	0.4
68.	344	F9	511	splinter flake, partially cortical	4.0	2.7	1.4
69.	346	F10	694	end-scraper with recessed retouching of the side edge	4.4	1.5	0.4
70.	346	F10	567	flake – fragment	2.0*	2.1	0.3
71.	346	F10	647	splinter flake, partially cortical	3.7	1.5	1.0
72.	346	F10	562	unipolar splintered piece	2.0	1.1	0.4
73.	118	F11	83	flake	1.5	1.8	0.4
74.	345	F11	OB. 357/A	flake core	2.3	1.8	1.1
75.	359	F11	962	splinter flake – fragment	1.6*	1.2*	0.3
76.	359	F11	981	splinter flake, partially cortical – fragment	1.3	1.2*	0.3
77.	359	F11	891	partially cortical flake	1.5	1.5	0.4
78.	359	F11	870	partially cortical flake	0.8	1.5	0.3
79.	359	F11	1022	splinter flake, partially cortical	1.1	0.7	0.2
80.	359	F11	924	cortical chip	1.0	1.2	0.1
81.	359	F11	982	technological chunk	2.9	1.9	1.1
82.	359	F11	955	splinter cortical flake	2.9	2.3	1.1
83.	233	F12	108	bipolar splintered piece – fragment	2.6*	2.0*	0.8
84.	369	G9	1061	retouched natural chunk	2.8	1.8	0.7
85.	369	G9		natural chunk	3.7	3.1	1.8
86.	238	G13	130	technological chunk	4.1	1.9	1.2
87.	238	G13	155	splinter flake – fragment	2.1*	2.6	0.6
88.	9/W	K15		flake core	2.4	3.3	3.3
89.	59	K11		gunflint	2.9	2.6	0.8
90.	235		OB. 320/A	flake	2.0	3.6	0.6
91.	?		OB.105	bipolar splintered piece	2.6	1.9	0.8

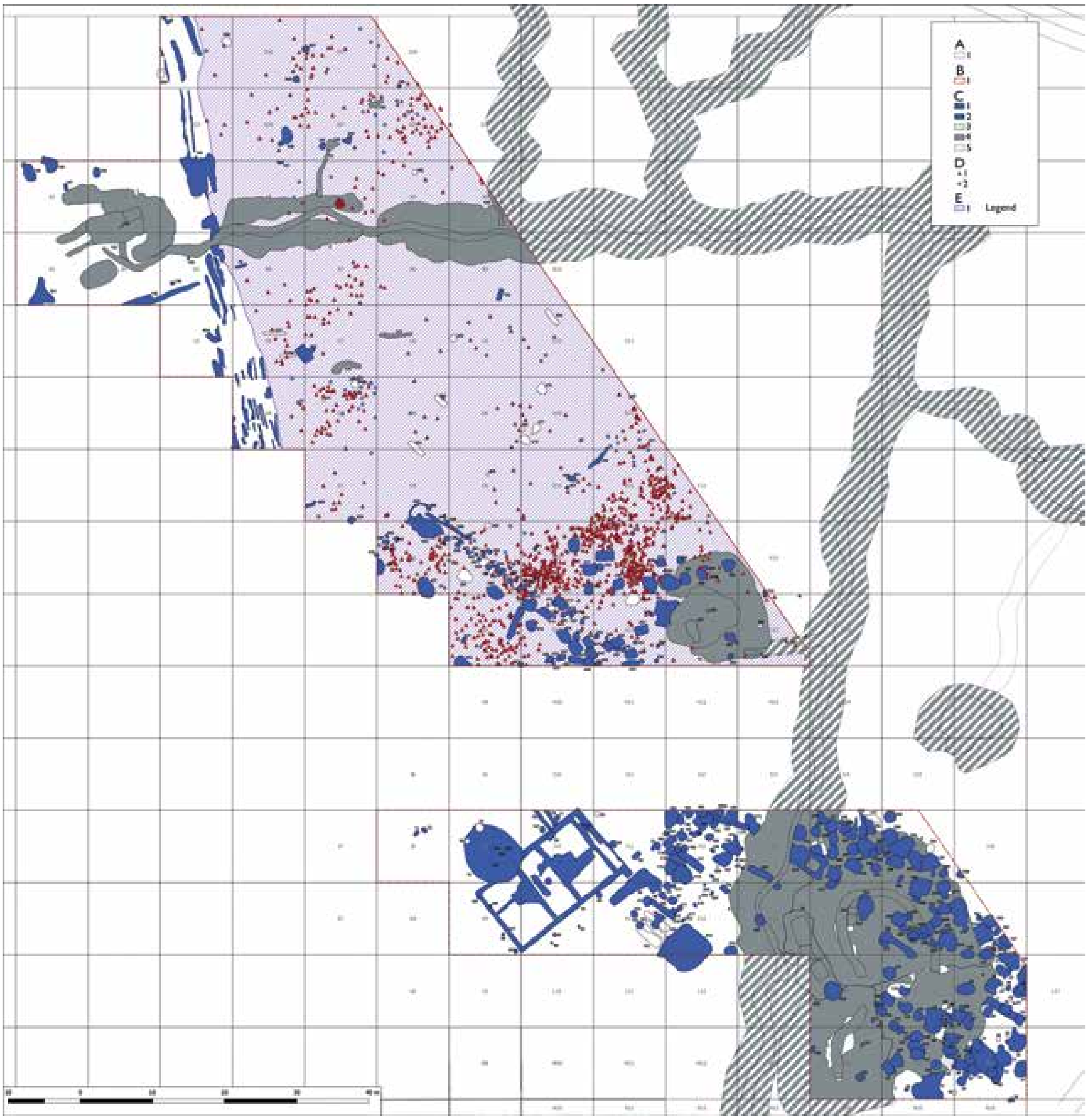

Fig.1. Żanęcin, Site 9, Wiązowna commune, Mazowieckie voivodship. Plan of the excavated part of the site. Legend: A1 – are square; B1 – excavated area; C – features (1 – modern times; 2 – 19th century/20th century; 3 – 20th century; 4 – 1944 AD; 5 – undetermined); D – artefacts (1 – pottery; 2 – flints); E1 – cultural layer (compiled by Adam Nowak, with modifications by Katarzyna Januszek).

there deliberately for future use, because their presence is not a typical feature of the local sandy formations.

Technological characteristics of flint artefacts

The inventory of flint artefacts contains debitage products representative of three knapping methods of blanks for tool-making: blade method, flake method and bipolar splinter method. However, not all of them reflect the whole *chaîne opératoire* related to the exploitation of all the aforementioned flint varieties. This is evident in the finds divided into nine categories of products (excluding six natural forms, see Tab. 2), each belonging to one of three technological groups: preliminary exploitation, blanks preparation and tools.

Preliminary exploitation group

It includes eight technological chunks (9.4% of the inventory of flint artefacts), mostly remains of early

Table 2. Żanęcin, Site 9, Wiązowna commune, Mazowieckie voivodship. Technological and raw material structure of the flint finds.

Categories of flint finds		Flint raw material					Σ
		Erratic		Mine		Undetermined	
		'local'	'north-eastern'	chocolate flint	Świeciechów flint		
Chunks and natural flakes		4	2				6
Technological chunks			6			2	8
Cores	blades	1	2				3
	flakes		2				2
Crested blades		1	1				2
Core tablets			1				1
Overpassed blades			1				1
Flakes		4	6	2	1	2	15
Blades			7	1			8
Bipolar splintered pieces		2	8				10
Splinter flakes		3	10			1	14
Chips		3	1	1			5
Tools	End-scrapers	1		3			4
	Scrapers		1	1			2
	Truncations					1	1
	Arrowheads		1				1
	Retouched flakes	1	2				3
	Retouched blades		2				2
	Retouched chunks and natural flakes	1	1				2
	Gunflints	1					1
Σ		22 24.1%	54 59.3%	8 8.8%	1 1.1%	6 6.6%	91

exploitation of the 'north-eastern' erratic flint (six finds) and scorched specimens made of unidentified raw material (two finds). In addition to the negatives created by initial direct percussion with a hard hammer, these chunks are characterised also by traces of bipolar splintering technique (specimens 982/F11 and 430/D7). Some bear signs of frost-induced fragmentation, which resulted in their destruction during processing. The technological chunks vary in size and depend on the shape of a given flint raw material – flat or polyhedral. They generally fall into three metric ranges: 1.2–4.3 × 1.0–2.8 × 0.6–1.2 cm.

Blanks preparation group

It contains 61 finds (71.7% of the inventory), including forms related to classical core reduction (37.6%)

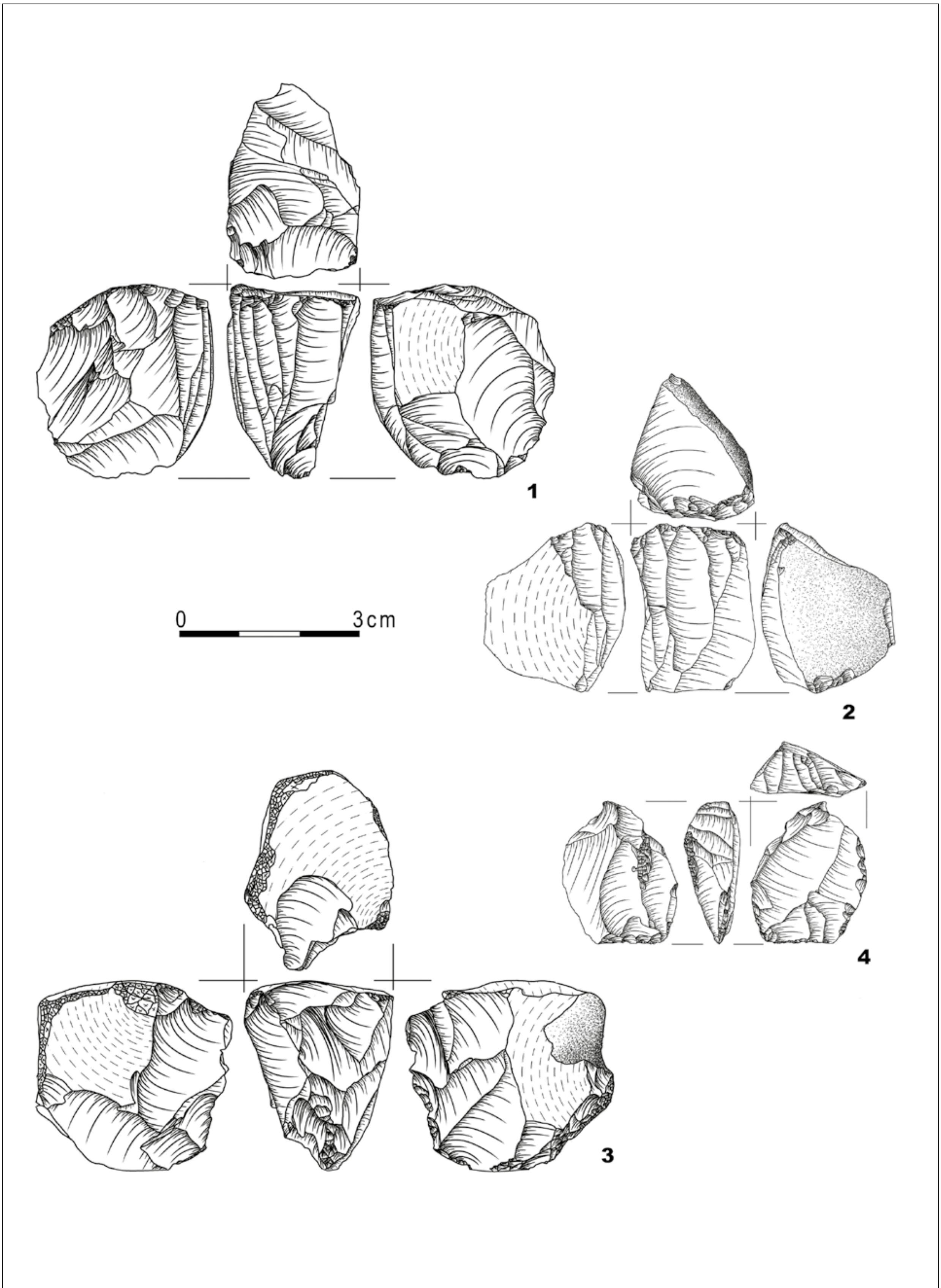

Fig. 2. Żanęcin, Site 9, Wiązowna commune, Mazowieckie voivodship. Selected flint artefacts: 1 – area unit D10/380; 2 – area unit ZZ7/213; 3 – area unit K15; 4 – feature 105 (drawing by Adam Nowak).

using the blade and flake methods, as well as traces of the bipolar splintering method (34.1%).

The blade method is associated with 14 finds (three blade cores, including one damaged, two fragments of crested blades, a broken overpassed blade and eight fragments of blades – 16.4% of the inventory).

The blade cores are single platform forms (one from the 'local' erratic flint and two from the 'north-eastern' variant), discovered in different parts of the excavation area (area units: ZZ7, D10 and E8). The cores made from the 'north-eastern' erratic flint represent two approaches to blade manufacturing.

The first one was formed from a polyhedral chunk, on which an elongated and prepared striking platform was created and, on its narrower side, a surface of debitage (Fig. 2: 1). The apex and rear of the core terminate with a sharp edge created deliberately during manufacturing. One of its sides has been prepared; the other retained its natural surface. The elongated striking platform has a characteristic active part, bearing negatives of rejuvenation flakes, and a passive part with traces of preparation. The edge of the striking platform is gently serrated. On the narrow surface of debitage, the negatives of fairly regular bladelets with sharply distal part are clearly visible. The core angle is set almost at a right angle. The aforementioned characteristic features of the core may indicate that it was used to obtain blades with the use of an intermediary tool. The specimen measures 3.1 × 2.1 × 3.0 cm.

The second core is a form obtained from a flattened, triangular chunk of flint, on which a striking platform was created by the removal of a cortical flake, and a rectangular surface of debitage was created on the narrower side (Fig. 2: 2). The sides of the core remained cortical. On the edge of the striking platform, a number of negatives are visible, likely levelling previous overhangs. Meanwhile, the surface of debitage shows clear negatives of blades with relatively irregular edges and oval or straight distal part. The core angle is acute. The discussed features of the core indicate that it was used to manufacture blades with the direct percussion technique with a hard hammer; the core measures 2.7 × 1.9 × 2.4 cm.

The next find is a form made of 'local' erratic flint with a damaged tip. It was formed from a flat frost flake with a naturally-formed striking platform. The edges of the striking platform show signs of abrasion. The core angle is acute. The blades detached from the core with the direct percussion technique with a hard hammer may have come from this specimen. The preserved size of the core is 3.0 × 2.2 × 0.9 cm.

The technical flakes preserved fragmentarily, that is, two crested blades, including a one-sided specimen and an overpassed blade, are hard to ambiguously link to the aforementioned cores. Only the distal fragment of the overpassed blade, originating from the single platform core and removing part of its apex with the prepared side, corresponds to one of the previously-discussed cores, exploited presumably with the direct percussion technique.

At the same time, all the blades found at the site are fragments (eight pieces) made of two types of flint (seven from 'north-eastern' erratic flint and one from chocolate flint, see Tab. 2). Six fragments were identified as distal (including the chocolate flint specimen), one as medial and one as proximal. The widths of the preserved fragments of blades can be categorised into four metric classes: 1.5 cm, 1.0–1.1 cm, 0.9 cm and 0.5 cm. Only the last of these may correspond to the widths of blade negatives found on the aforementioned core exploited with an intermediary tool. The distal fragment of the bladelet made of 'north-eastern' flint, matching the shape of the negatives on the debitage surface, may have come from the same type of core.

With certain reservations, 17 forms may be classified as remnants of the flake method, which amounts to 20% of the whole inventory. Only two cores and 15 flakes were included in this number. Some of the latter may also be associated with the blade-manufacturing method, as they could have originated during the preliminary preparation of blade cores. In general, the most prevalent types of the discussed artefacts were those made of 'north-eastern' erratic flint (Tab. 2).

One specimen made of the 'local' erratic flint – greatly reduced, reoriented, with one striking platform formed and another, natural, found on the side of the core after reorientation – was also counted among these cores. The core angle is acute. This specimen was exploited by direct percussion with a hard hammer. It measures 2.3 × 1.8 × 1.1 cm. The next specimen is an initial, single platform flake core, from which only one flake was chipped off striking the prepared striking platform. Prior to that, this core could have been a blade pre-core with a discernible crest (Fig. 2: 3), because it matches the core described above in terms of morphology and raw material (Fig. 2: 1).

Among the 15 discovered flakes, forms made of several varieties of flint were distinguished, as well as two specimens that could not be classified in terms of raw material due to being burnt (Tab. 2). Four made of different raw materials are damaged in various areas. Three partially cortical flakes made of 'local' erratic flint were identified, measuring 1.4–4.0 × 1.2–3.2 × 0.2–0.3 and 0.7 cm, including one with perpendicular negatives. Only one negatives specimen, with a damaged base, has unidirectional negatives – consistent with the direction of debitage.

Among the six flakes of the 'north-eastern' variant of erratic flint, one cortical specimen measuring 0.8 × 1.5 × 0.3 cm can be distinguished, along with two partially cortical pieces measuring 1.4–1.5 × 1.2–1.5 × 0.4 cm, including one with perpendicular negatives, and three negatives specimens measuring 1.2–2 × 1–2.1 × 0.2–0.4 cm, one of which also shows perpendicular negatives.

Two flakes are made of chocolate flint – one partially cortical, measuring 2.7 × 1.8 × 0.9 cm, and another damaged specimen with perpendicular negatives, with preserved dimensions of 2 × 1.2 × 0.6 cm. Meanwhile, the only negatives specimen made of Świeciechów flint, obtained from a single-platform core, measures 2.0 × 3.6 × 0.6 cm. The remaining two forms, made of an undetermined raw material, consist of a partially cortical flake and negatives flake with perpendicular negatives. These categories of flakes cannot be directly linked to the discovered cores. Indirectly, based on raw material types, only the products made of erratic flint can be attributed to flake method exploitation at the site. In contrast, the other specimens made from mined flints (chocolate and Świeciechów flint) should not be associated with local production due to the absence of cores and other precore forms made of these flint varieties.

Remains of the bipolar splinter method are represented by 29 specimens (34.1% of the inventory), composed almost exclusively of erratic flints, with the exception of one burned specimen. These include 10 bipolar splintered pieces, 14 splinter flakes and five chips. The formation of the latter may also result from the use of other methods involving a hard hammer. Most of the bipolar splintered pieces (eight specimens) are made of 'north-eastern' flint, while only two belong to the 'local' variety of erratic flint. These specimens were processed using a hard hammer on a hard anvil. Among them, four bipolar examples were distinguished, measuring 1.6–2.6 × 1–1.9 × 0.7–0.8 cm, one of which is a transformed rejuvenation flake removing part of the blade core's striking platform (Fig. 2: 4). The next group consists of two unipolar forms measuring 1.3–2.0 × 1.1–1.3 × 0.4 cm, as well as two with altered orientation, measuring 2.3–2.9 × 2.0–2.6 × 0.4–0.7 cm. The remaining specimens are two incomplete bipolar splintered pieces, damaged in various areas. The identified splinter flakes (14 specimens) include a cortical flake measuring 2.9 × 2.3 × 1.1 cm, eight partially cortical flakes measuring 1.1–4.0 × 0.7–2.7 × 0.2–1.0 cm, and two negative flakes with opposed negatives, each 1.7 × 1.4 × 0.3 cm, originating from the exploitation of bipolar splintered pieces. Additionally, three specimens have been preserved only fragmentarily due to burning or frost damage.

The spatial dispersion of bipolar splintering method remains at the site indicates local exploitation. Bipolar splintered pieces and splinter flakes were most commonly recorded as single specimens within the following excavation area units: D7, E12, F9 and F10. However, in unit F11, four splinter flakes were found near area unit F12, where only a single bipolar splintered piece was recorded. A similar situation applies to the northern part of the investigated area, where four splinter flakes were noted within area unit ZZ8, while in the adjacent area unit ZY8, only a single bipolar splintered piece was found.

Tool group

Sixteen tools were identified (18.8% of the flint artefact inventory), classified into eight types. They were formed from blanks obtained through the exploitation of erratic flints and mined chocolate flint (Tab. 2).

The most numerous tools in this group are end-scrapers (four specimens), including three made of chocolate flint, differentiated by the type of blanks used – one flake and two blade specimens – as well as one end-scraper made of 'local' erratic flint. The first of these was made from a flake with multidirectional negatives, measuring 1.4 × 1.6 × 0.4 cm (Fig. 3: 1). The next was manufactured from a partially cortical blade with opposed negatives, originating from a double-platform core. In addition to its shaped scraping edge, this specimen features two inverse retouched notches on its lateral edge and micro-retouching on part of the second lateral edge (Fig. 3: 2). Its dimensions are 4.4 × 1.5 × 0.4 cm. It may also represent a combined tool. The last end-scraper made of chocolate flint was formed from a blade obtained from a single-platform core (Fig. 3: 3). The negatives of regular blades on the dorsal side of the blanks may indicate that it was removal using pressure technique. This tool is characterised by a low scraping edge and additional semi-steep retouch along the lateral edge. Its dimensions are 3.4 × 1.3 × 0.3 cm. The next end-scraper of this type, made from 'local' raw material, is preserved only fragmentarily, making it impossible to determine the specific blank from which it was formed. Its current dimensions are 1.2 × 0.9 × 0.4 cm.

The next tool group – scrapers – consist of two specimens made of flakes obtained from the 'north-eastern' erratic flint (Fig. 3: 4) and chocolate flint (Fig. 3: 5). The first one was created from a partially cortical flake, obtained from a single-platform core through direct percussion with a hard hammer. Its dimensions are 2.4 × 1.4 × 0.5 cm. The second scraper, measuring 2.2 × 1.4 × 0.6 cm, was shaped from a partially cortical flake, removal from a single-platform core with a hard hammer.

The highlighted truncations are represented by a double specimen made of flint raw material undetermined due to burning, found in area unit D7. It was shaped from the distal, bent fragment of a blade from a single-platform core. The dimensions of the tool are 2.1 × 1.0 × 0.4 cm.

The next type – arrowheads – includes a laurel-shaped arrowhead with a short tang (Fig. 3: 6). It was most likely made from a flake of 'north-eastern' erratic flint through surface retouch, covering mostly both sides of the tool. Its dimensions are 2.7 × 1.1 × 0.3 cm.

Three distinguished retouched flakes were obtained from erratic flints (Tab. 2). All of them were documented

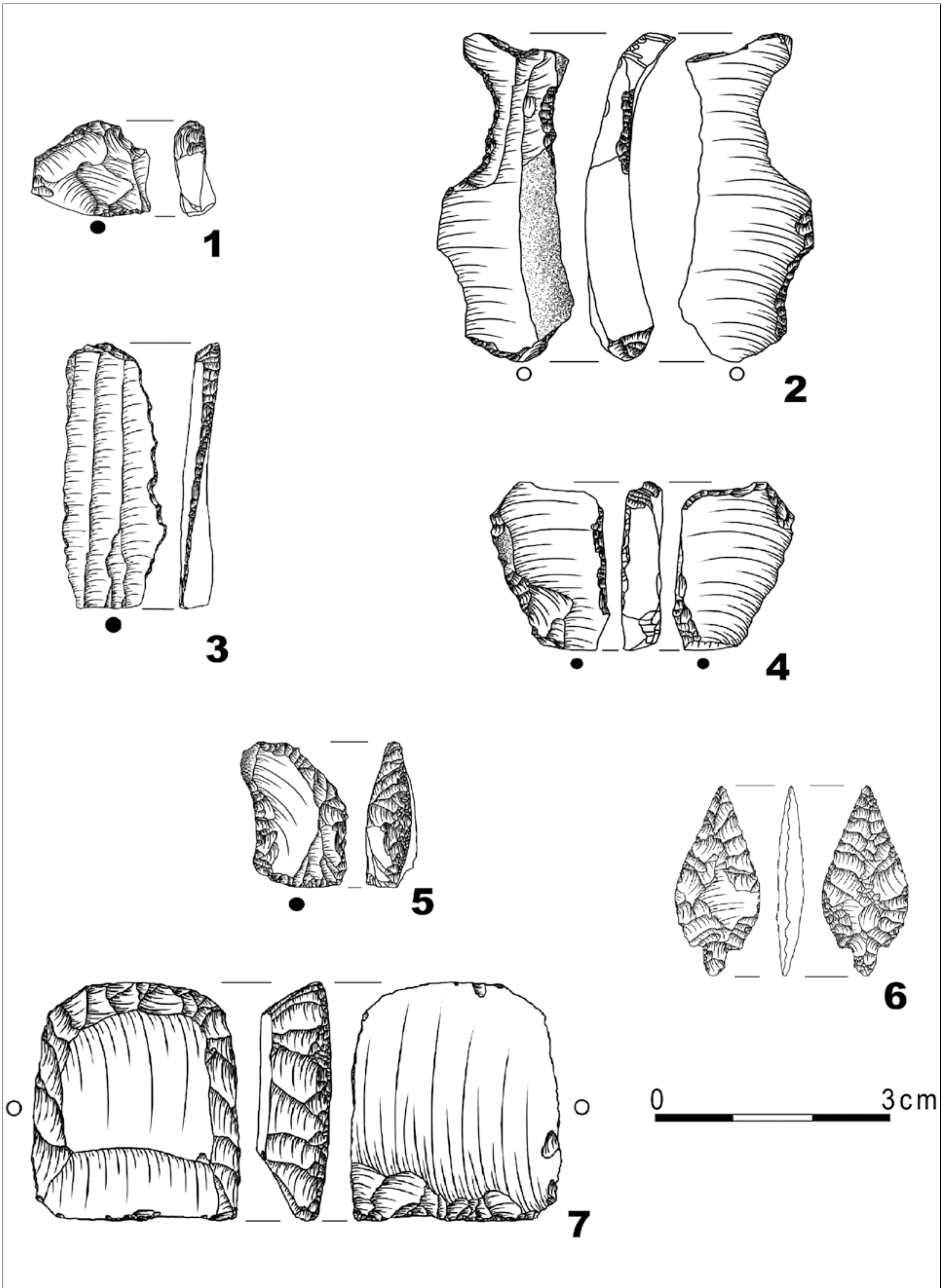

Fig. 3. Żanęcin, Site 9, Wiązowna commune, Mazowieckie voivodship. Selected flint artefacts: 1 – area unit D11/422; 2 – area unit F10/694; 3 – area unit D11/412; 4 – area unit D7/459; 5 – area unit D11/424; 6 – area unit ZY7/281; 7 – area unit K11 (drawing by Adam Nowak).

within the excavation area unit D7. The specimen made of the 'north-eastern' flint is a retouched splinter flake, measuring 2.9 × 3.8 × 0.8 cm. The others, produced through various retouching of negative flakes obtained by direct percussion with a hard hammer, measure between 1.2–1.9 × 1.3–1.9 × 0.3–0.5 cm. One of these, made of the 'north-eastern' erratic flint, with opposed negatives and a natural, flat and wide butt, may originate from core preparation.

Two retouched blades are made of the 'north-eastern' erratic flint, also discovered within the excavation area unit D7. One of them is a distal fragment of a partially cortical blade from a double-platform core, with micro-retouch along the edges. Its preserved dimensions are 1.0 × 0.9 × 0.3 cm. The other specimen comes from a single-platform core and has a partially retouched lateral edge, which is also shiny at the retouch place. The dimensions of this tool are 3.2 × 1.4 × 0.3 cm.

The group of tools also includes retouched chunks and natural flakes. These forms are made from two varieties of erratic flint (Tab. 2). They are represented by a natural flake with retouch along the edge, measuring 3.6 × 1.9 × 0.5 cm, discovered in the excavation area unit ZZ7, and a retouched chunk measuring 2.8 × 1.8 × 0.7 cm, found within the area unit G9.

The last distinguished type is the gunflints. This category includes a specimen measuring 2.9 × 2.6 × 0.8 cm, made of cretaceous flint, most likely of the 'north-eastern' variety, documented outside the finds from the cultural layer in the area unit K11. This gunflint was made from a piece of massive blade (para-blade?) removed from a single-platform core. It was shaped using semi-steep retouch along the broken edges and the lateral edge of the blank (Fig. 3: 7). It belongs to the horseshoe-shaped gunflints subtype according to Marek Lalak's typology.[13] Its sharp striking edge, corresponding to the lateral edge of the blank, is characterised by the presence of splinter retouch, the negatives of which are visible on the ventral face. It is currently not possible to determine the origin of this type of retouch, which may have resulted from the work of a flintlock or could have been created during the final processing of this item on a hard anvil.[14]

Results

Generally, at Site 9, the primary raw material used was cretaceous erratic flint, brought in the form of small chunks. The 'north-eastern' variety of this flint was exploited using the blade method with a punch and direct percussion with a hard hammer. The first technique produced very fine bladelet debitage, and the *chaîne opératoire* at the site ends with this type of waste. There are no tools formed from this type of blanks, however. These remains were recorded within the excavation areas units D10 and D11. On the other hand, larger and especially broader blades were removed from single-platform cores using direct percussion. Unfortunately, the blanks present in the inventory mostly consist of distal parts of blades, the characteristics of which prevent confirmation of the specific technique used to produce them. Only one tool – a retouched blade – was made from blank obtained using this technique and its width corresponds to some of the distal fragments found at the site, suggesting it may also fall within the range of widths of debitage surface of cores exploited through direct percussion. These elements suggest that blanks for blade tools were produced at the site using the mentioned technique and that few tools were made from them. Remains of this process were documented in several adjacent excavation unit areas: ZZ7, A6 and A7 (core and blade fragments), C9 and C10 (blade fragments) and D7 (blade fragment and tool).

In relation to the production of blanks for flake tools from the mentioned variety of erratic flint, it can be concluded that they were likely not manufactured using a separate flake method. This is evidenced by the absence of greatly reduced flake cores. Instead, the necessary blanks for flake tools may have been obtained by forming blade cores through direct percussion with a hard hammer. The fact that the inventory contains cortical or partially cortical flakes, those with opposed negatives, as well as a few flake tools (a scraper made from a partially cortical flake, a retouched flake with a natural butt and opposed negatives) seems to suggest such activities.

The application of the bipolar splinter method using a hard hammer and hard anvil is also linked to the exploitation of the 'north-eastern' variety of flint at the site. Although this method generates the largest number of morphologically diverse flakes in an uncontrolled manner, the latter's use as blanks for tool production is limited to just one retouched specimen.

On the other hand, the traces of processing the 'local' erratic flint suggest the use of both the flake and bipolar splinter method at the site. The presence of a fragment of a blade core, without blades from this variety of raw material, may indicate that this specimen was collected and brought to the site as raw material. The blanks obtained through the flake method were transformed into a few tools (an end-scraper (?), a retouched flake). The use of the bipolar splinter method, however, is different. It pertains exclusively to the formation of bipolar splintered

[13] Lalak 2006, 229.

[14] *Cf.* Lalak 2006, 231, no. 26.

pieces, not the production of blanks for tool making. No tools were recorded to have been made from splinter flake of the 'local' variety of erratic flint.

In the case of the two varieties of erratic raw materials, the demand for tools was met without the need to produce blanks. This is indicated by the retouched natural forms (a flake and a chunk).

Regarding the varieties of mined flint, it should be noted that both chocolate flint and Świeciechów flint were not exploited at the site. The forms present in the inventory made of the former – morphologically diverse tools of two types, as well as a few remains of debitage – suggest that they were probably collected and brought from differently-dated sites. The same applies to the specimen made of Świeciechów flint.

The documented and chronologically diverse elements of weaponry made from cretaceous flint, most likely of the 'north-eastern' variety – namely an arrowhead and a gunflint – also do not suggest local production.

Relative chronology of flint artefacts

Site 9 yielded a relatively undistinctive and rather limited collection of flint artefacts, mostly originating from the cultural layer, which is visible over an area of nearly 40 ares (excavation area units). However, taking into account their context – co-occurrence with pottery, which should be considered a substitute for a calendar – as well as the technological characteristics of the remains from certain stages or the entire *chaîne opératoire* carried out on specific flint raw materials, it is possible, with a reasonable degree of probability, to also suggest their chronological position. Based on these premises, it can be stated that the flint sources point to several chronologically distinct settlement episodes during the Late Mesolithic, the Bronze Age and modern times.

The production of bladelets from single-platform cores, shaped from the 'north-eastern' variety of erratic cretaceous flint, can be associated with the first of the mentioned periods. The form of the recorded core, exploited using an indirect percussion, is similar to the classical Janislavician core.[15] Remains of such activities were noted within the unit areas D10 and D11.

The subsequent settlement episode at the site, which occurred during the Bronze Age (Early Bronze Age), is represented by the majority of the flint materials discovered in association with TCS pottery from its classical phase. These primarily include debitage related to the exploitation of erratic flints using hard hammer with the bipolar splinter method, blade and flake methods, as well as a few tools made from the blanks obtained by these methods. Items made of chocolate flint and Świeciechów flint, associated with earlier cultural units (e.g., Late Palaeolithic – an end-scraper made from a blade obtained from a double-platform core), can also be linked to the activities of the TCS community, most likely as a result of the acquisition of raw material gathered from other sites. Such remains made from chocolate flint are known from camps of the aforementioned cultural sphere in Mazovia, associated with its pre-classical phase (e.g., Raszyn, Site 7; or Reguły, Site 14),[16] and even from a ritual feature linked to the initial phase of this cultural sphere (Skrzeszew, Site 49, Feature 1).[17] This may indicate that during the classical developmental phase of the TCS community in Mazovia, earlier methods of obtaining flint raw material continued to be practised.

Most likely, the small, tanged arrowhead, with retouched surface, found in the northern part of the investigated area (area unit ZY7), can be linked to the Late Bronze Age. The Lusatian culture pottery found at a short distance (area unit ZZ8) seems to confirm the context of the occurrence of this type of arrowhead outside compact assemblages, as noted by other researchers.[18]

On the other hand, the gunflint, discovered outside the cultural layer (area unit K11), is associated with the modern time period. No debitage related to the manufacturing of this type of item have been recorded within the investigated area. Therefore, it can be assumed that this object originates from an unspecified region of mass production of such items. The time span of the use of gunflints is limited to the period when firearms with flintlocks were used. In Poland, this period is very broad: from the 18th century to the early 20th century.[19]

Conclusions

In the case of Żanęcin 9, flint was used in two ways. The first of them concerned the exploitation of two varieties of erratic flints, brought from outside the site and its dune surroundings, using various methods and techniques. This procedure was initially employed by the late Mesolithic Janislavician communities, limiting it only to the production of blades. Later, in the Early Bronze Age, the population associated with TCS not only produced blanks, but also transformed them into makeshift tools.

The second type of use of flint was limited to bringing of finished artefacts for various purposes. One of these could have involved the procurement of flint raw

[15] Wąs 2005, 128–129.

[16] Manasterski, Januszek 2011, 63–66; Januszek, Manasterski 2011, 88–100.

[17] Januszek, Manasterski 2012, 118, 125–129.

[18] Borkowski, Kowalewski 2013, tab. V: 1, 87.

[19] Lalak 2006, 221.

material, sourced from older sites in the form of artefacts made from mined flint. This method of supply was known to the TCS communities. Another purpose could have been related to the use of weaponry. This applied both to the representatives of the Lusatian culture in the Late Bronze Age, who left behind characteristic arrowheads, and to users of flintlock firearms in modern times, who discarded horseshoe-shaped gunflints.

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